

Model PM-1440GS Lathe

High precision 3 HP gap-bed machine, with 2-axis DRO
2 inch spindle bore, with stock-centering spider
D1-5 camlock spindle mount
40 in. between centers, 14 in. swing over bed, 19-3/4 in. over gap
8 spindle speeds from 60 to 1800 rpm
Multi-speed gearbox for full-range screw cutting, TPI & mm pitch
Bidirectional power feed for saddle & cross-slide
Weight, including cast iron stand & coolant system 1800 lb



PM-1440GS standard configuration Includes 2-axis DRO, 3-jaw (reversible) & 4-jaw chucks, faceplate, coolant system, footbrake, worklight, steadies, wedge-type QC toolpost, assembled on cast iron stand



PM-1440GS

FAQ



My lathe doesn't run at all (1)



POWER light off, left arrow?

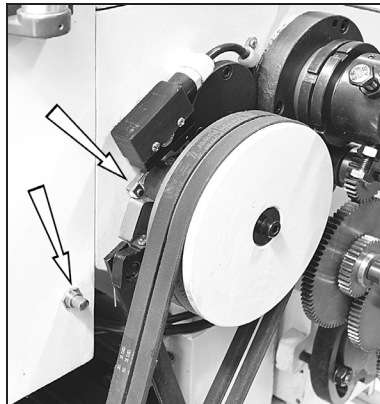
240 Vac power connected?

Circuit breaker in the electrical box tripped?

E-STOP button in, right arrow? Rotate it, should pop out.



My lathe doesn't run at all (2)



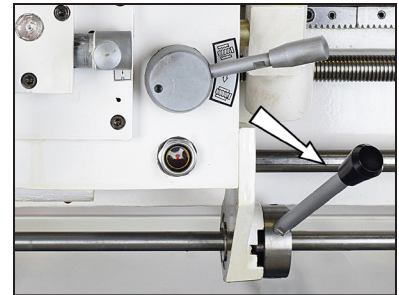
Belt cover in place? This closes the interlock switch, bottom arrow.

FOOTBRAKE working, not stuck down? If working properly, the footbrake should close the microswitch, top arrow, opening it when released.

CHUCK GUARD swung back? Close the guard (photo, cover page).



The motor didn't run when power was connected



By design it should NOT run if the Motor Control lever is UP or DOWN when power is connected.

Electrical schematic, Section 5: Move the Motor Control switch to neutral, mid travel, to energize the power-switching contactor KA, thus restoring normal conditions.

This manual contains essential safety advice on the proper setup, operation, maintenance, and service of the PM-1440GS lathe. Failure to read, understand and follow the manual may result in property damage or serious personal injury.

There are many alternative ways to install and use a lathe. As the owner of the lathe you are solely responsible for its proper installation and safe use. Consider the material contained in this manual to be advisory only. Quality Machine Tools, LLC cannot be held liable for injury or property damage during installation or use, or from negligence, improper training, machine modifications or misuse.

This manual describes PM-1440GS machines as shipped from November 2016. There may be detail differences between your specific machine and the information given here (with little or no impact on functionality). Please email us if you have questions about any aspect of the manual or your machine (see our website www.precisionmatthews.com for support addresses). Your feedback is welcomed!

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Section 1 INSTALLATION



THESE ARE THE MAIN POINTS TO WATCH OUT FOR! *But read the following pages for more information*

- Handling the lathe is at least a two-man job.
- Lifting gear – sling, hoist or forklift – must be rated for at least 1-1/2 tons.
- Working location of the mill must allow space for removal of the belt cover at left; also, access to the coolant system (back of right hand cabinet) and the electrical box at the back of the headstock.
- Power requirement is 220V, 60Hz, 1 ϕ , 20A circuit protection (spindle motor 12A full load).
- Extension cord not recommended; if no alternative, use 12 AWG not longer than 20 ft.
- Before connecting power be sure that:
 1. The machine is on a firm footing.
 2. Chuck camlocks tight, no wrench left in chuck.
 3. Saddle and cross slide approx. mid-travel, power feed disengaged (Figure 1-9).
 4. The headstock gear selectors are set for the lowest spindle speed.

SETTING UP THE LATHE

The PM-1440GS is shipped fully assembled in a single packing case. The machine can be lifted in one piece by an overhead hoist or forklift with slings and/or chains, all items rated for a total weight of at least 1-1/2 tons. To lift the machine clear of the pallet use 1 inch diameter steel bars through the holes in LH and RH stand cabinets, Figure 1-1.



Figure 1-1 Lifting holes



Figure 1-2 Top-adjusting leveling mount (optional)

Install six 500 lb-rated leveling mounts in the mounting holes of the two stand cabinets, 4 for the left hand cabinet, 2 for the right. Alternatively, level the lathe using metal shims under the cabinets. The mounts shown in Figure 1-2, available from Precision Matthews, allow leveling adjustment from above. To install this type of mount, remove the threaded stem from the inverted cup stamping (yellow), then place the cup under the stand with holes aligned — no washer between stand and mount. If there is insufficient headroom in the stand, shorten the threaded stem; re-install it, with washer and locknut, through the hole in the stand. Once the stem has bottomed in the mount, further rotation of the stem (using a wrench) expands the inner core of the mount, thus raising its upper surface.

Inspect the coolant tank and pump assembly in the RH cabinet, Figure 1-3. The tank may have become dislodged in shipment. Level it if necessary.

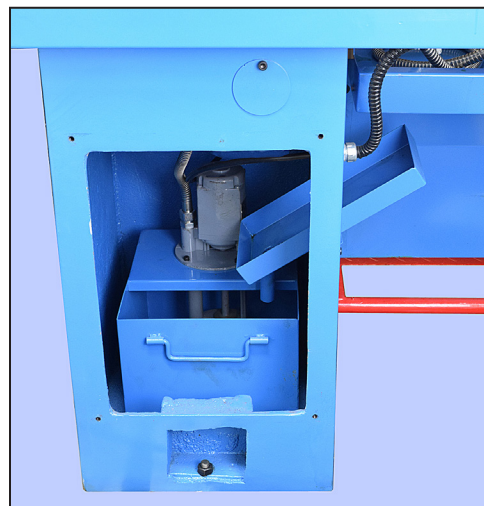


Figure 1-3 Coolant tank

CLEANUP

Metal surfaces may have been protected by thick grease and/or paper. Carefully remove these using a plastic paint scraper, disposable rags and a light-oil such as WD-40.

CHIP TRAY

Check that the chip tray, Figure 1-5, can be pulled forward without snagging coolant hoses and worklight wiring. Use cable ties if necessary.

LEVELING

Make sure the lathe is in its permanent location. The following procedure ensures that the lathe bed is in the same state as it was when the lathe was checked for accuracy in manufacture — level from end to end along the bed, and from front to back. In other words, no warping.

Make sure all leveling mounts and/or shims are **properly weight bearing**, firmly in contact with the floor. Check and adjust level from end to end using a precision machinist's level, if available. If not, use the most reliable level on hand. Check and adjust level front-to-back across the bed using a matched pair of spacer blocks to clear the Vee tenons on the bed ways. The blocks need to be at least 1/4 inch thick, ground or otherwise accurately dimensioned. Alternatively, check for level on the ground surface of the cross slide as the carriage is traversed from end to end. See also "Aligning the Lathe" in Section 4.

FOOTBRAKE & BELT COVER INTERLOCKS

The lathe will not run if the belt cover is removed, allowing the interlock switch to open, Figure 1-4. The same applies if the footbrake switch fails to close when the foot treadle is released (brake OFF). Both switches should be checked before power is connected.

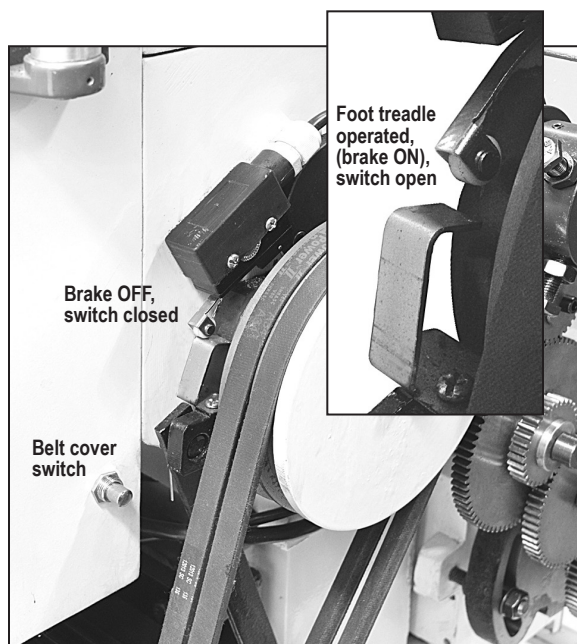


Figure 1-4 Footbrake & belt cover interlocks

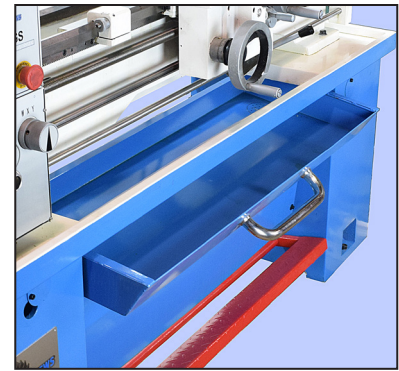


Figure 1-5 Slide-out chip tray

POWER CONNECTION

As shipped, the PM-1440GS is set for 220 V. If your supply is nominally 240 V, it may be desirable to alter connections to the 24V transformer in the electrical box.

Read Initial Checks, next page, before connecting power

If the lathe did not come with a pre-installed power cord, connect to the power source using 12 AWG (minimum) 3-wire cord through a strain relief bushing sized for the electrical box ports. Depending on installed options and other factors, the entry point shown in Figure 1-6 may not be available. Connect the ground wire (PE) to the grounding plate at bottom left. Connect L1, L2 to the left-most two terminals on the bottom terminal strip (the wires may be marked L, N instead of L1, L2).

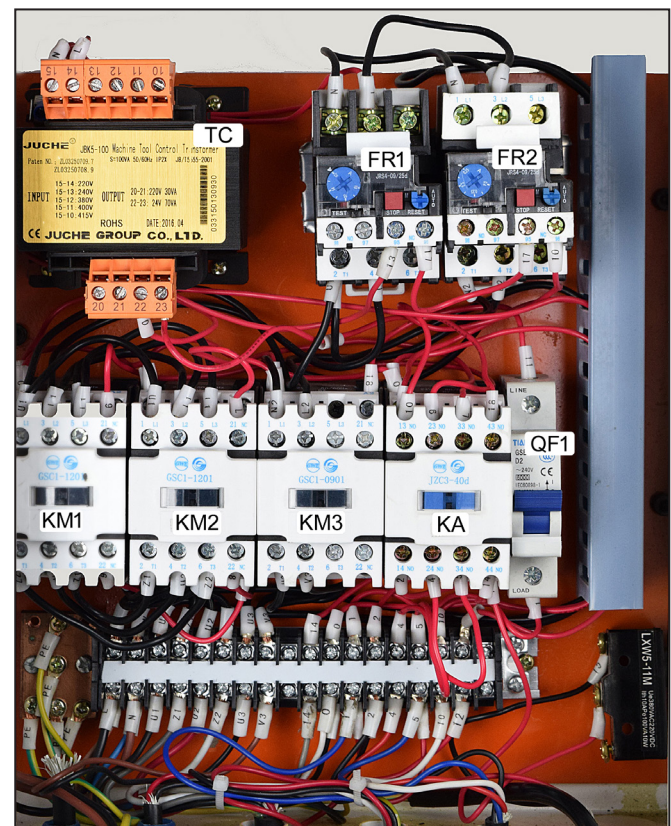


Figure 1-6 Electrical box inputs/outputs

This configuration may vary depending on installed options, etc.

INITIAL CHECKS

Read Section 3 if unsure about any item in the following

! BEFORE connecting power, do the following:

1. Visually check the entire machine for possible disturbance in shipping, including the motor, Vee belts and external gears under the belt cover left of the headstock. Replace the belt cover.
2. Check oil level (sight glasses) in the **headstock**, the **carriage feed gearbox**, and the **apron**. See Section 4.
3. If a chuck or faceplate is installed, check tightness of the six Camlocks on the spindle nose, Section 3.
4. Lower the chuck guard, photo on page 1.
5. Check the spider, left-hand end of the spindle. Locknuts on the four clamp screws should be tight. Make sure that the clamp screws clear the cover when the spindle is rotated by hand
7. Set the H-L gear levers to the lowest spindle speed, 60 rpm. Make sure the gears are properly meshed by "jiggling while shifting" — rotate the chuck back and forth by hand while moving the levers into position. Make certain that the motor control lever is set to OFF, mid-travel, Figure 1-7.

! Do not change speed when the motor is running.

8. Set the Saddle Feed Direction lever to its center (OFF) position, Figure 1-8.
9. Check that there are no clamps or locks on moving parts.
10. Check that the footbrake treadle is released (UP).
11. Set the saddle and cross slide to approximate mid-travel.
12. Connect 220 Vac power. The power lamp, Figure 1-8, should light, unless a circuit breaker in the electrical box has tripped.
13. Be sure the Emergency Stop (E-Stop) button has not been pushed in (it should pop out when twisted clockwise).
14. Shift the motor control lever DOWN. The spindle should turn Forward, counter clockwise, viewed at the chuck (nose) end. **The control system can be rewired for DOWN = Reverse, see the electrical diagram, Section 5.**
15. Check the emergency function by pressing the E-Stop button. The motor should stop. **If this doesn't happen, the E-stop function is defective, and needs attention.**
16. Reset (twist) the E-Stop button to restore power.
17. Check that the chuck guard switch stops the motor when the guard is swung up.
18. Check that the belt cover interlock stops the motor when the belt cover is removed.
19. Check that the footbrake stops the motor.
20. Return the motor control lever to OFF, mid-travel. The motor should stop.
21. Shift the motor control lever UP. The spindle should Reverse, clockwise rotation, viewed at the chuck (nose) end. **The control system can be rewired for UP = Forward, see the electrical diagram, Section 5.**

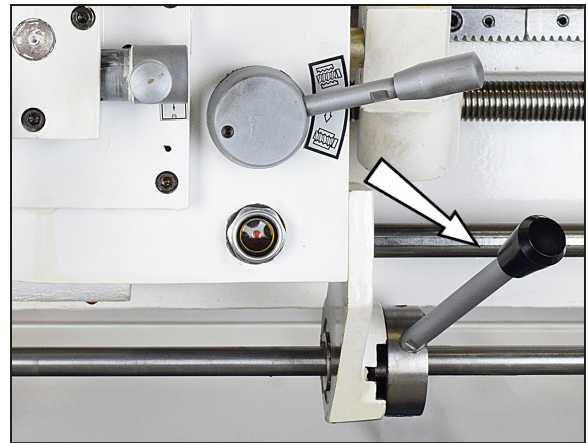


Figure 1-7 Motor control lever
Mid-travel OFF, DOWN Forward, UP Reverse



Figure 1-8 Front panel controls

OPTIONAL TEST RUN PROCEDURE

Run the spindle for a few minutes, forward and reverse, at a selection of the available 8 speeds.

The carriage feed gearbox should also be run at this time, but first make certain that the leadscrew and feed shaft oilers at the tailstock end have been lubricated.

Also note: In initial tests, because the saddle and cross slide should first be exercised manually, the leadscrew split-nut should be disengaged — ditto the saddle/cross-slide power feed lever, Figure 1-9. The power feed lever can be either in or out, but it should be centered, neither up nor down.

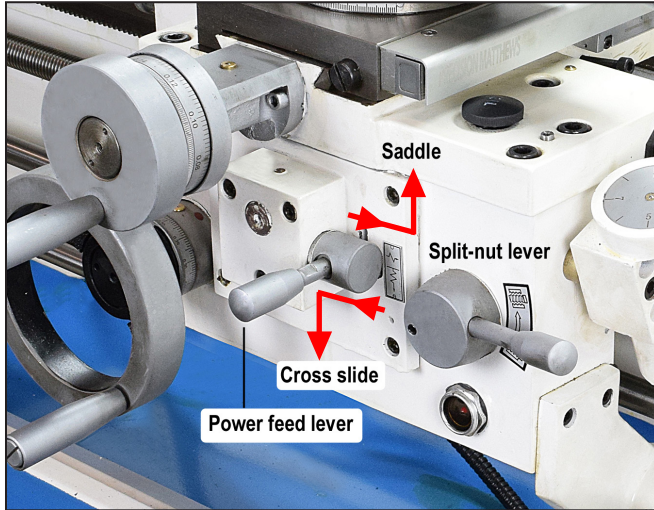


Figure 1-9 Feed control levers on apron

Saddle Power feed lever OUT & UP to engage. **Cross-slide** Lever IN & DOWN to engage. Test for dis-engagement by turning the saddle and cross-slide handwheels.

After the initial test run, perhaps with a few additional hours of machine time, some users drain and refill the headstock and carriage feed gearbox. Lubricants are specified in Section 4. Other users prefer to delay this service action for at least 50 hours of running time. No specific recommendation is given by Precision Matthews.

ALIGNING THE LATHE

The most important attribute of a properly set up lathe is its ability to “machine parallel”, to cut a cylinder of uniform diameter over its entire length. In other words, no taper.

Leveling of the lathe is a part of this, see earlier in this section. Equally important is the alignment of the center-to-center axis with the lathe bed, as seen **from above**. [Vertical alignment is nowhere near as critical, rarely causing taper unless the lathe is damaged or badly worn.] For more information see the final pages of Section 4, Servicing the Lathe.

Section 2 FEATURES & SPECIFICATIONS

MODEL PM-1440GS Lathe

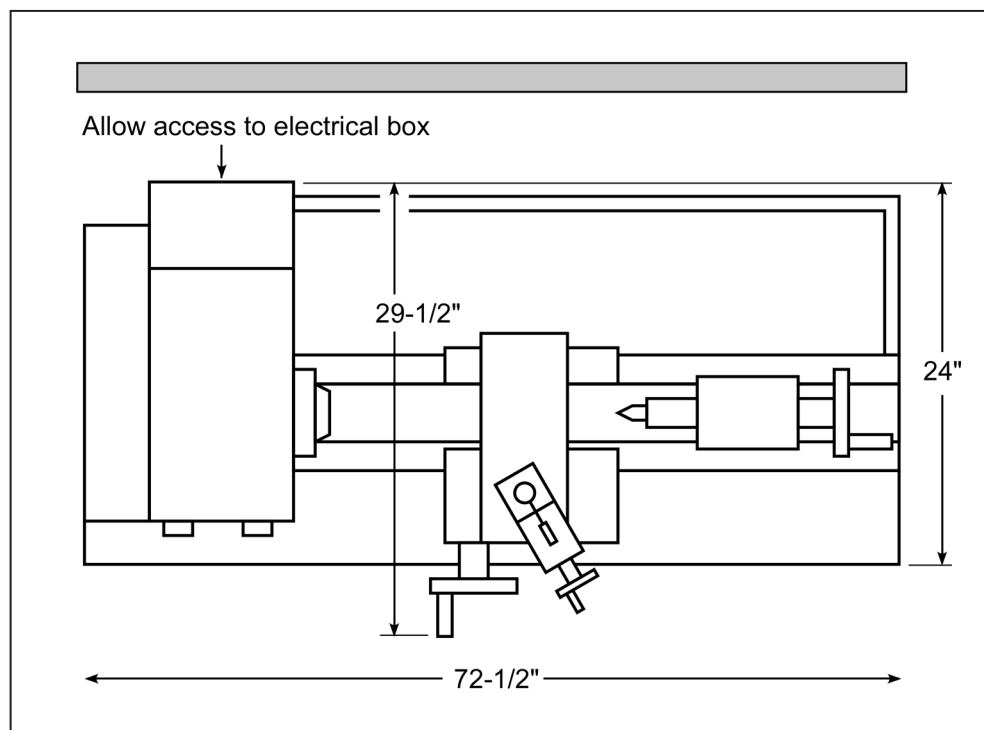
General information

This is a gap-bed lathe with 2-axis DRO designed for day-in, day-out use in the larger model shop. Distance between centers is 40in., swing over the bed 14 in. With an all-up weight of 1800 lb, plus 8 spindle speeds from 60 to 1800 rpm, the PM-1440GS is a robust heavy-duty machine. The spindle nose is D1-5 Camlock. A quick-change carriage feed gearbox provides a full range of leadscrew ratios for U.S. and metric screw cutting, together with an independent power feed for both saddle and cross slide. The power feed shaft is driven through a friction clutch that allows the saddle to be stopped precisely at any point along the bed.

The 2-inch bore spindle comes with a stock-centering spider and MT6 internal taper. It runs on high-precision NSK tapered-roller bearings, and is driven by a 3 HP (2200 W) 220 Vac single-phase motor. A treadle-operated drum brake stops the spindle instantly, even at the highest speeds. A circulating coolant system is installed in the right hand stand cabinet.

Accessories included

- 8 in. 3-jaw self centering chuck with two sets of jaws, in-facing and out-facing
- 8 in. 4-jaw independent chuck with reversible jaws
- 200 Series precision wedge-type Quick Change toolpost, with 5 toolholders
- Steady rest
- Follower rest
- Micrometer saddle stop
- Worklight



PM-1440GS Floor plan: dimensions approximate (not to scale)

PM-1440GS SPECIFICATIONS

Dimensions, approximate overall, incl. stand	Including stand: Width 71-1/2 in. x Height 51 in. x Depth 31 in. (full range cross slide motion)
	Footprint: 71-1/2 in. wide x 24 in. deep
	Bed length 54 in.
	Weight, approximate: 1800 lb net

Power requirement	220 - 240Vac, 60 Hz, 1Ø, 12A full load
Motor	TEFC type, cap start, 2.2 kW (3 HP), 1725 rpm

Work envelope

Center to center	40 in.
Spindle face to tailstock quill face	43-1/4 in.
Gap insert length	7-1/2 in.
Swing over gap	19-3/4 in. diameter
Swing over bed	14 in. diameter
Swing over cross slide	8-3/4 in. diameter
Saddle travel	38 in.
Cross-slide travel	7-3/4 in.
Compound (top slide) travel	3-3/4 in.

Drive system

<i>(Belt drive with 8-speed gearbox)</i>	
Low range, rpm	60, 100, 170, 265
High range, rpm	420, 690, 1150, 1800

Carriage drive, thread cutting	Leadscrew 8 tpi
Inch threads	Choice of 42, from 4 to 112 TPI
Metric threads	Choice of 44, from 0.1 mm to 7 mm pitch

Saddle drive, turning operations	Choice of feed rates from 0.002 to 0.118 in./spindle rev
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Cross slide drive, facing operations	Choice of feed rates from 0.0005 to 0.03 in./spindle rev
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Spindle

Chuck/faceplate attachment	D1-5 Camlock
Internal taper	MT6
Spindle bore	Clearance for 2 in. diameter
Spindle length	17 in. overall

Tailstock

Internal taper	MT4
Quill travel	4 in.

Work holding

3-jaw chuck, 8 in., self-centering (scroll)	Reversible jaws
4-jaw chuck, 8 in., independent	
Faceplate	
Center rest (steady rest) capacity	Up to 3 in. diameter
Follower rest capacity	Up to 1 in. diameter



Everyday precautions

- This machine is intended for use by experienced users familiar with metal-working hazards.
- Untrained or unsupervised operators risk serious injury.
- Wear ANSI-approved full-face or eye protection at all times when using the machine (everyday eyeglasses are not reliable protection against flying particles).
- Wear proper apparel and non-slip footwear – be sure to prevent hair, clothing or jewelry from becoming entangled in moving parts. Gloves – including tight-fitting disposables – can be hazardous!
- Be sure the work area is properly lit.
- Never leave chuck keys, wrenches or other loose tools on the machine.
- Be sure the workpiece, toolholder(s) and machine ways are secure before commencing operations.
- Use moderation: **light** cuts, **low** spindle speeds and **slow** table motion give better, safer results than “hogging”.
- Don’t try to stop a moving spindle by hand – allow it to stop on its own.
- Disconnect 220 Vac power from the lathe before maintenance operations such as oiling or adjustments.
- Maintain the machine with care – check lubrication and adjustments daily before use.
- Clean the machine routinely – remove chips by brush or vacuum, not compressed air (which can force debris into the ways).

***No list of precautions can cover everything.
You cannot be too careful!***

Section 3 USING THE LATHE

What is not in this section ...

The PM-1440GS is a conventional engine lathe that requires little explanation except for details specific to this particular model — speed selection, thread cutting, and the saddle/cross-slide power feed system. Because the user is assumed to be familiar with general purpose metal lathes, this section contains very little tutorial.

MOTOR CONTROLS Figure 3-1

Before doing ANYTHING, check the installation instructions and power-up procedure in Section 1

STOP the motor before changing speed

Don't use JOG unless the gears are fully meshed



Figure 3-1 Main control panel

Before connecting power to the lathe, be sure the Motor Control Lever on the apron is set to OFF, Figure 3-2. Connect the lathe to a 220 Vac outlet — the POWER lamp should light — then operate the Motor Control Lever to run the spindle in the desired direction.

Check that the following interlocks function correctly:

- E-Stop button
- Chuck guard
- Belt cover (to the left of the headstock)
- Footbrake

JOG FEATURE

"Jog" is momentary-type push-button, active only if the Motor Control lever is in the mid-travel (OFF) position, Figure 3-2. Press the button briefly to "nudge" the spindle in reverse by a few degrees. Jog can be used to reposition the chuck and/or workpiece, especially when low spindle-speed gearing makes hand rotation difficult.

The control system can be rewired for "Forward Jog", see the electrical diagram, Section 5.

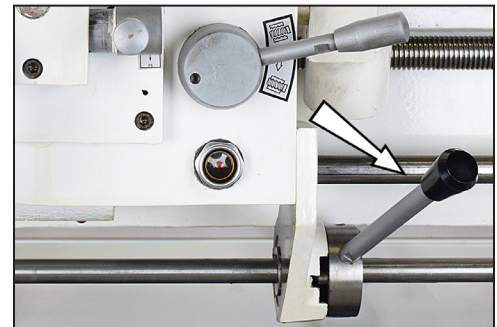


Figure 3-2 Motor control lever
Mid-travel OFF, Down FORWARD, Up REVERSE

DRIVE TRAIN

Double-groove pulleys connect the motor to the gearbox, Figure 3-3. Belt tension will not usually require attention. If necessary, loosen the three hex head bolts securing the motor, Figure 3-4. Adjust the motor to re-tension. Make certain the motor is properly aligned, then re-tighten the bolts.

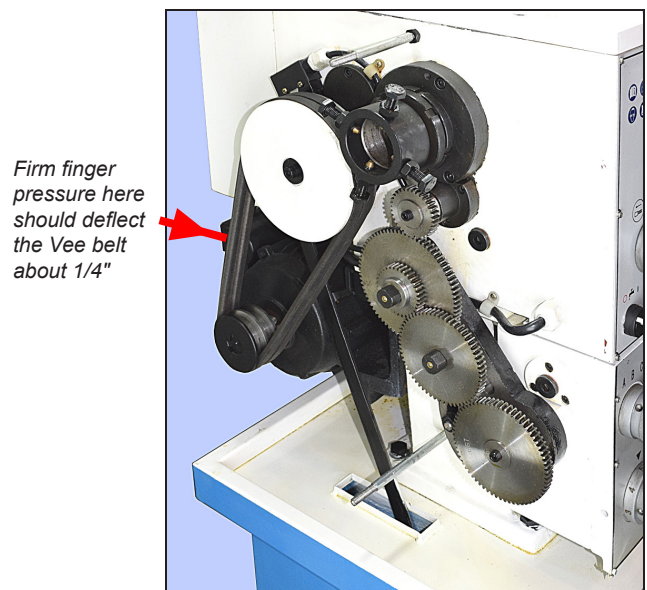


Figure 3-3 Vee belts & external change gears

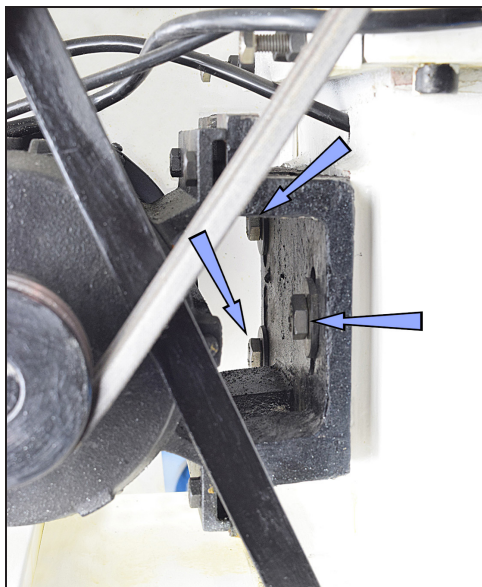


Figure 3-4 Motor attachment bolts

SPINDLE SPEEDS

The PM-1440GS has an eight-speed headstock gearbox with two shift levers, L-H & Speed Selection, Figure 3-1. Before changing speed, use the Motor Control lever to **STOP THE MOTOR**, then move the shift levers to the desired setting. This may need a little patience because it is not always possible to go directly from one mesh to another. Move the spindle back and forth by hand while trying to ease the lever into its detent (meshed) position. **Don't use the JOG button in this process** — this may cause gear damage.

	SPINDLE SPEED (RPM)			
H RANGE	1150	1800	690	420
L RANGE	170	265	100	60

CARRIAGE FEED DIRECTION

The lever below the speed selectors on the front panel, Figure 3-1, determines whether the saddle feed is right to left — the usual direction for turning and thread cutting — or reversed. The selected direction applies to both the leadscrew and the saddle/cross slide power feed.

Before changing feed direction, **STOP THE MOTOR**. Hand-turn (jiggle) the spindle while feeling for the mesh, as above. To disengage the power feed, set the Saddle Feed lever to its mid-position.

CHUCKS & FACEPLATE

The spindle nose on the PM-1440GS accepts D1-5 Camlock chucks, faceplates and other work holding devices.

A D1-5 chuck or faceplate is held by six threaded studs, each with a D-shape crosscut to engage a corresponding cam in the spindle nose, Figures 3-5, 3-6. The function of the cams is to pull the chuck backplate inward to locate its internal taper firmly on the spindle nose.

Alongside each stud is a stop screw, the head of which fits closely in a groove at the threaded end of the stud. The function of the stop screw is not to clamp the stud in place, but instead to prevent it from being unscrewed when the chuck is out on the bench.

! All stop screws must be present & fully tightened! Camlock action can jam any stud lacking a stop screw — a serious problem.



Figure 3-5 D1-5 faceplate

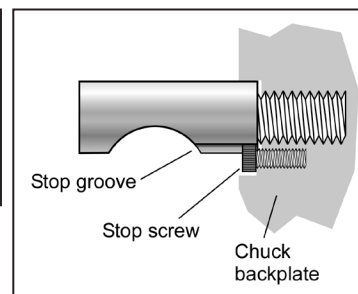


Figure 3-6 Camlock stud

TO INSTALL A CHUCK

Disconnect the 220V supply from the lathe!

D1-5 chucks and faceplates are heavy, some more than 30 lb. They will cause serious damage if allowed to fall. Even if a chuck is light enough to be supported by one hand, the lathe bed should be protected by a wood scrap, as Figure 3-7. Some users add packing pieces, even custom-made cradles, to assist “straight line” installation and removal.

Before installing make certain that the mating surfaces of the chuck/faceplate and spindle are **free of grit and chips**.

The cams on the spindle are turned with a square-tip wrench similar to the chuck key (may be same tool in some cases).

Recommended procedure:

1. Select the highest spindle speed (1150 rpm) to allow easier hand rotation of the spindle. (Alternatively, try moving the speed selection levers between detents to find a “between teeth” condition to disengage the gear train.)



Figure 3-7 Protect the lathe bed

2. Turn the spindle by hand, checking that all six cam markers are at 12 o'clock.
3. While **supporting its full weight**, install the chuck without tilting, see Figure 3-8, then gently turn each of the cams **clockwise** — snug, firm, but not locked in this first pass.

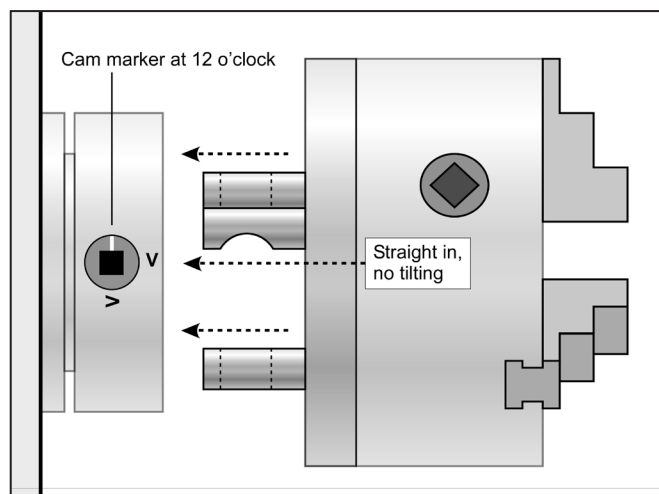


Figure 3-8 Installing a Camlock chuck

4. Check that each of the cam markers lies between 3 and 6 o'clock, between the two Vees stamped on the spindle, Figure 3-9.
5. If any cam marker is **not** within the Vees, first be sure that there is **no gap** between chuck backplate and spindle flange. Also, remove the chuck to inspect the studs — burrs can be a problem, hone if necessary. **If there are no visible problems, the stud in question may need adjustment as follows:**
 - Remove the stop screw from the stud.
 - If the cam marker in question can't get to the first Vee (3 o'clock), back the stud **OUT** one full turn, then replace the stop screw.

- If the cam marker goes beyond the second Vee (6 o'clock), screw the stud **IN** one more turn, then replace the stop screw.
- If the markers are correctly aligned, repeat the tightening sequence as step 3, light force. Repeat the sequence two more times, first with moderate force, then fully tighten.

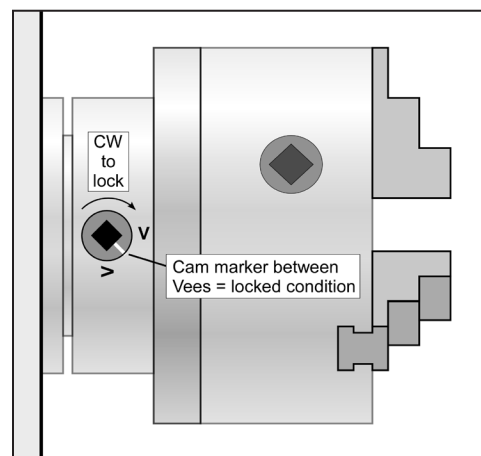


Figure 3-9 Cam in locked condition

TO REMOVE A CHUCK OR FACEPLATE

Disconnect the 220V supply from the lathe!

Protect the lathe bed, as Figure 3-7. While supporting its weight, turn each of the cams to 12 o'clock, Figure 3-8, then remove the chuck. If the chuck does not come free, try tapping the backplate gently with a soft (dead blow) mallet.

CROSS SLIDE & COMPOUND

The cross slide and compound, Figure 3-10, both have 10 TPI leadscrews, with 100-division graduated collars, so each division represents a "real" motion of 0.001". On the cross slide dial, only, this shows as 0.002" per division, meaning that a 0.001" depth of cut reduces the diameter of the workpiece by 0.002".

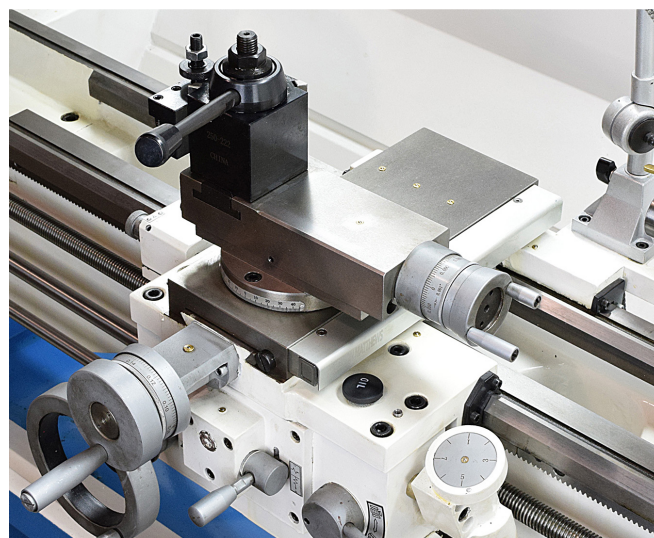


Figure 3-10 Cross slide and compound dials

TAILSTOCK

The tailstock leadscrew has a 10 TPI thread, with 4 inch travel. A graduated collar on the tailstock handwheel reads 0.001"/division. To remove tooling from the tailstock taper (MT4) turn the handwheel counter-clockwise (handle end view) until resistance is felt, then turn the handle a little more to eject the tool. Conversely, to install a taper tool make certain that the quill is out far enough to allow firm seating.

For taper turning the tailstock may be offset by adjusting set screws on either side, Figure 3-11. To move the tailstock to the front, for instance, the screw on the lever side would be unscrewed, then the opposing set screw would be screwed in to move the upper assembly.

A visual indication of the offset is provided by a scale on the back surface, but this is not a reliable measure for precise work. In practice, the only way to determine the offset precisely is to "cut and try" on the workpiece, or scrap stock, homing in on the correct degree of offset in small increments.

The same issues arise when re-establishing "true zero" of the tailstock, in other words returning it to the normal axis for routine operations. One way to avoid cut-and-try is to prepare in advance a bar of (say) 1" diameter quality ground stock, with **precise center drillings** at both ends (do this by indicating for zero TIR in a 4-jaw chuck, not in a 3-jaw unless known to be predictably accurate). The prepared bar can then be installed between centers and indicated along its length.

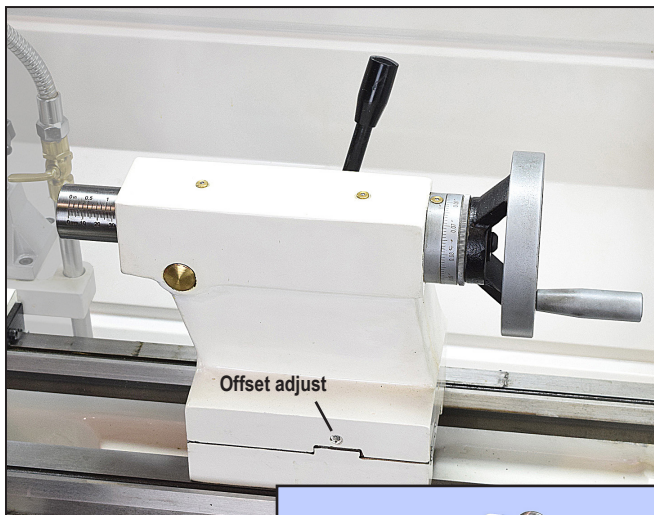
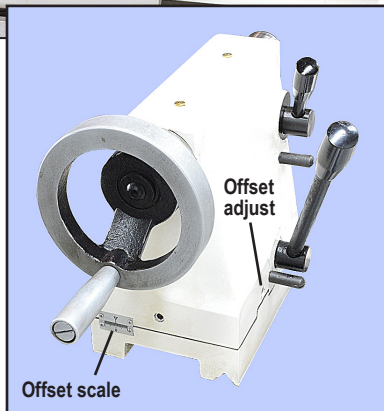


Figure 3-11 Tailstock



SADDLE FEED GEARBOX

! Stop the motor before changing feed direction or rate

The saddle feed can be to the left, right, or disengaged, as selected by the Saddle Feed Direction lever on the main control panel, Figure 3-1.



Figure 3-12 Saddle feed gearbox controls

The rate of power feed relative to spindle speed is set by the four shifter knobs below the main control panel, Figure 3-12. The **W-X-Y** knob at right determines which is the driven shaft, leadscrew (**W** and **Y**) or feed shaft (**X**).

Select W to cut U.S. threads (TPI), Y for metric threads

A distinctive feature of the PM-1440GS is its ability to cut a wide range of U.S. and metric threads with only two external gear sets, Figures 3-13 and 3-17.

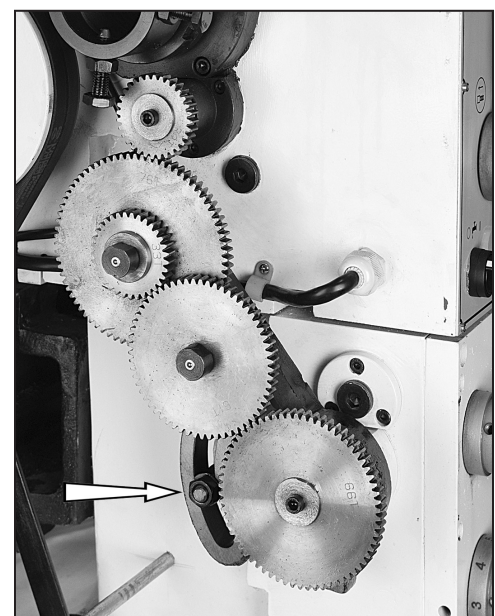


Figure 3-13 External gear set F To change gear sets loosen the 17 mm nut, arrowed, then swing down the support casting (quadrant).

ENGAGING THE POWER FEED

Power feed controls are located on the apron, Figure 3-14. The split-nut lever engages the leadscrew, and is typically used only for screw cutting (W-X-Y knob on gear box set to either W or Y).

The power feed lever is active only when the **feed shaft** is rotating, W-X-Y knob on gear box set to X. When the lever is pushed LEFT (cross slide) or RIGHT (saddle), the lever tip is captive to prevent incorrect up/down movement.

When engaging power feed, **move the lever gently**, feeling for the gears to mesh as you go. If the gears don't engage at the first try, use the appropriate handwheel to jog the saddle or cross slide, whichever one you wish to move under power.

The split-nut lever, used only for screw cutting, cannot be engaged unless the power feed lever is NEUTRAL, neither up or down

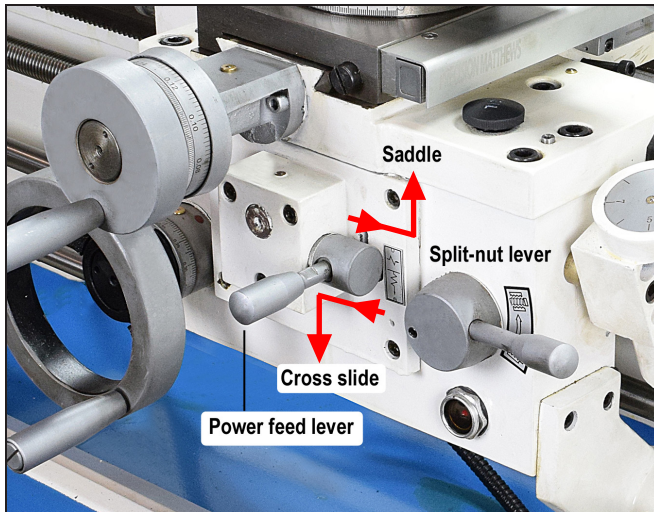


Figure 3-14 Feed control levers on apron

Saddle Power feed lever RIGHT & UP to engage. **Cross-slide** Lever LEFT & DOWN to engage. Test for dis-engagement by turning the saddle and cross-slide handwheels.

FEEDSHAFT CLUTCH

The clutch shown in Figure 3-15 disengages the power feed if the saddle or cross slide hits an obstruction when power feeding, thus minimizing the potential for damage. This could be the result of either an accidental event, or deliberately stopping the saddle at a precise location set by the stop, Figure 3-16.

The clutch comprises a pair of spring loaded steel balls bearing on a detent disc driven by the saddle feed gearbox. Spring pressure is adjusted by two set screws on either side of the feed shaft, arrowed in Figure 3-15. Setting the spring pressure is a process of aiming for the best compromise between too high — damaging feed pressure — and too low, which might mean unexpected stopping for no good reason.

Setting the clutch to work reliably with the micrometer carriage stop is a good example of such a compromise: start with low spring force, then work up in small increments until the carriage stops in the same location (say $\pm 0.002''$, assuming a constant depth of cut and feed rate).

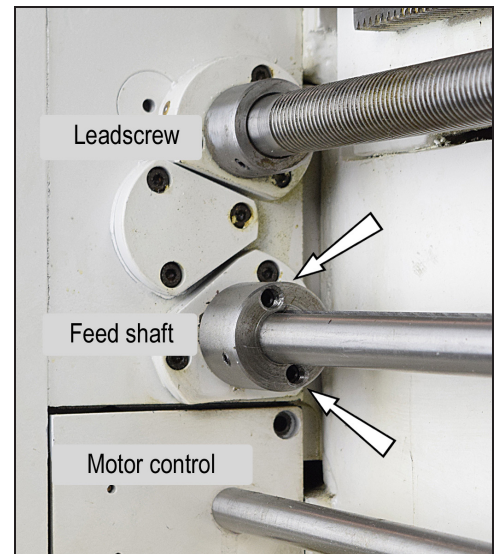


Figure 3-15 Feedshaft clutch

SADDLE STOP

The stop assembly, Figure 3-16, has a micrometer-style collar graduated in 0.001 in. divisions. It can be clamped at any point along the lathe bed (two M6 socket head screws on the underside secure the clamp plate to the block). Make certain that the stop rod seats firmly on the saddle casting.

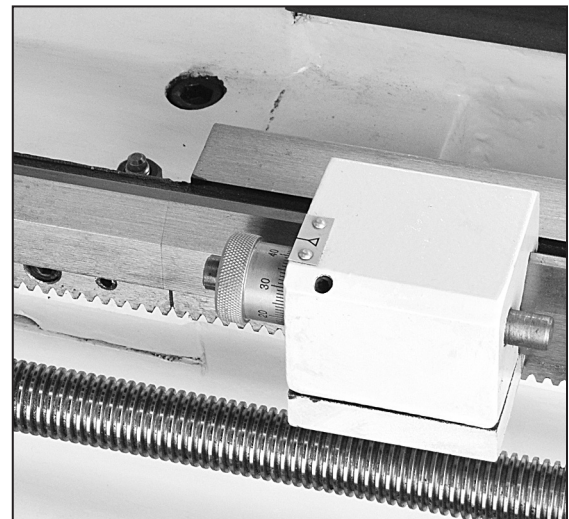


Figure 3-16 Micrometer saddle stop

EXTERNAL GEAR RATIOS

Referring to the gear tooth numbers in Figure 3-17, set G drives the saddle 4 times faster than F. This means that **G is for coarse threads/feeds**, and **F is for fine**.

Ratio of external gear sets G & H relative to F

F = 1 (fine thread)

G = F x 4 (coarse thread)

H = F x 3.14 = F x π

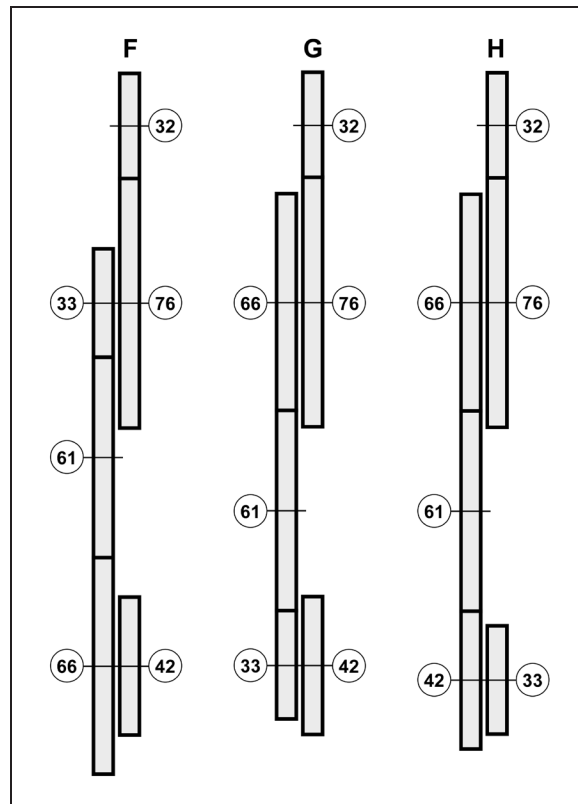
[Gear set H is the "pi factor" that enables the PM-1440GS to convert from the circular pitch of a worm wheel to the linear pitch of a matching worm.]

When exchanging gears, make sure that the external gears are properly meshed. One way to gauge the gap between gears is to insert a scrap of paper between the teeth as a separator (use standard printer paper, about 0.004" thick).

Be sure the gears are lubricated!

Figure 3-17 External gear sets

Screw cutting operations use only sets F and G (special-purpose set H is for worm cutting). Convert from F to G by exchanging the 33T and 66T gears.



POWER FEED RATES

The following table lists inches of travel per revolution of the spindle. Saddle motion is about 3.6 times cross slide motion.

	1		3		6		8	
	Saddle	X slide	Saddle	X slide	Saddle	X slide	Saddle	X slide
FATX	0.002	0.0005	0.002	0.0006	0.003	0.0007	0.003	0.0008
FASX	0.003	0.0009	0.004	0.0012	0.005	0.0014	0.006	0.0016
FARX	0.007	0.0019	0.008	0.0023	0.010	0.0028	0.012	0.0032
FBRX	0.017	0.0046	0.021	0.0058	0.025	0.0069	0.029	0.0081
GBSX	0.034	0.0092	0.042	0.0115	0.050	0.0139	0.059	0.0162
GBRX	0.067	0.0185	0.084	0.0231	0.101	0.0277	0.118	0.0323

SCREW CUTTING — U.S. THREADS

UN Coarse & UN Fine

The following table lists threads per inch (TPI).

Gear Set F cuts all UNF threads from #0 to 3/4", plus UNC from #1 to 3/8"

Gear Set G cuts all UNF threads from 7/8" to 1-1/2", plus UNC from 7/16" to 1-1/2".

	1	2	3	4	5	6	7	8
GCTY	4	4-1/2	5	5-1/2	5-3/4	6	5-1/2	7
GCSY	8	9	10	11	11-1/2	12	13	14
GBY	9-1/2	9-1/2	9-1/2	9-1/2	9-1/2	9-1/2	9-1/2	9-1/2
FCTY	16	18	20	22	23	24	26	28
FCSY	32	36	40	44	46	48	52	56
FBY	38	38	38	38	38	38	38	38
FCRY	64	72	80	88	92	96	104	112

SCREW CUTTING — METRIC THREADS

The following table lists thread pitch in mm.

Gear Set F cuts all **fine** threads from M1 to M18 diameters, plus all **coarse** threads from M1.6 to M12 diameters, with a single exception (M5 x 0.8).

Gear Set G cuts all **coarse** threads from M14 to M68 diameters, plus M5 x 0.8.

	1	2	3	4	5	6	7	8
FATW	0.1		0.125			0.15		
FASW	0.2	0.225	0.25			0.3		0.35
FARW	0.4	0.45	0.5	0.55		0.6	0.65	0.7
FBSW						0.75		0.875
GASW	0.8	0.9		1.1		1.2	1.3	1.4
FBRW	1		1.25			1.5		1.75
GARW	1.6	1.8						
GBSW	2	2.25	2.5	2.75		3	3.25	3.5
GBRW	4	4.5	5	5.5	5.75	6	6.5	7

WORM CUTTING — U.S.

The following table lists **DP** (Diametral Pitch) values for worm-wheels, and the gearbox settings to cut matching worms. Example: a 16DP worm wheel has a **Circular Pitch** of $\pi \div DP = 3.142 \div 16 = 0.1963$ ". This is the distance between a point on one tooth of the worm-wheel and the corresponding point on its adjacent tooth.

A matching worm has a **Linear Pitch** of the same value. In other words, the "thread pitch" of the worm is also 0.1963". In the table the setup for this pitch is **HCTY-1**. Compare this with GCTY-1 (U.S. threads table, preceding page) for a 4 TPI thread, pitch 0.25". Gear set H runs the leadscrew slower ($\pi/4$) than G, so the worm pitch is $0.25 \times \pi/4 = 0.1963$ ".

	1	2	3	4	5	6	7	8
HCTY	16	18	20	44	23	24	26	28
HCSY	32	36	40	44	46	48	52	56
HBV	38	38	38	38	38	38	38	38
HCRY	64	72	80	88	92	96	104	112

WORM CUTTING — METRIC

The following table lists **Module** numbers for metric worm-wheels, and the gearbox settings to cut matching worms. (Module is the inverse of diametral pitch, but with the pitch circle diameter measured in millimeters instead of inches.) Example: a **Module 1.5** worm-wheel has a **Circular Pitch** of $\pi \times 1.5 = 4.712$ mm. This is the distance between a point on one tooth of the worm-wheel and the corresponding point on its adjacent tooth.

A matching worm has a **Linear Pitch** of the same value. In other words, the "thread pitch" of the worm is also 4.712 mm. In the table the setup for this is **HBRW-6**. Compare this with GBRW-6 (Metric threads table, preceding page) for a thread of 6 mm pitch. Gear set H runs the leadscrew slower ($\pi/4$) than G, so the worm pitch is $6 \times \pi/4 = 4.712$ mm.

	1	2	3	4	5	6	7	8
HATW	0.1		0.125			0.15		
HASW	0.2	0.225	0.25	0.275	0.2875	0.3	0.325	0.35
HBTW						0.375		
HARW	0.4	0.45	0.5	0.55	0.575	0.6	0.65	0.7
HBSW		0.5625	0.625	0.6875		0.75	0.8125	0.875
HBRW	1	1.125	1.25	1.375		1.5	1.625	1.75

COMPOUND SETUP FOR THREAD CUTTING

Thread cutting on the lathe is unlike most other turning operations, for two reasons: 1. The cutting tool must be precisely ground with an included angle of 60 degrees for most American and metric threads, and; 2. It is preferable to feed the tool into the workpiece at an angle so it cuts mostly on the left flank of the thread. The correct angle relative to the cross slide (zero degrees) is a subject of debate — should it be 29, 29-1/2 or 30 degrees? Many machinists prefer 29 degrees because it holds the cutting tool marginally clear of the right flank of the thread, close enough for cleanup of the flank while at the same time avoiding appreciable rubbing.

The 45° - 0° - 45° scale on the compound is not directly helpful in setting the thread cutting angle, but it can be used for that purpose if a second reference mark is applied to the cross slide. First make certain that the compound is truly aligned with the lathe axis when 0° on the scale is on the cross slide

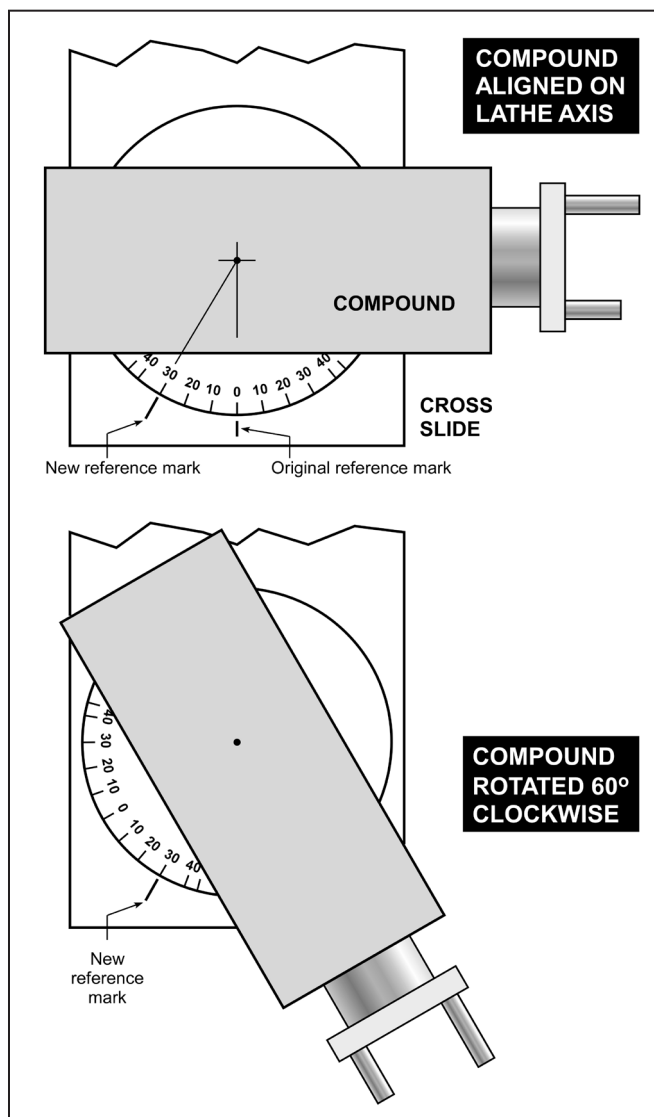


Figure 3-18 **Setting up the compound for 30° infeed**
A new reference mark is stamped on the cross slide at 30 degrees. To set the compound for thread cutting, rotate it clockwise to bring the right hand 30° scale mark in line with the new reference mark. For 29° rotate the compound 1 degree more.

reference mark — do this by indicating against a ground bar between centers while advancing the indicator using only the compound. Allow for the variance, if any, when applying the new reference mark. Grind a chisel edge on a 1/4 in. square HS tool bit, align it precisely on the left hand 30° scale mark; then rap the tool bit sharply with a hammer.

CUTTING PROCEDURE FOR TPI THREADS

This procedure assumes that a single point thread cutting tool will be used, and that the threading dial assembly has been pivoted forward to engage its worm wheel with the leadscrew, Figure 3-19.

The threading dial cannot be used for metric threads! The split-nut on the apron must be left engaged throughout the entire process.



Figure 3-19 **Threading dial**

For metric and UNC/UNF threads the tool is ground to 60° (included angle). It is installed so that its flanks are exactly 30° either side of the cross axis, ideally with the compound offset as Figure 3-18. Single-point threads are cut in 10 or more successive passes, each shaving a little more material off the workpiece.

To make the first thread-cutting pass the leadscrew is run at the selected setting (table on page 15), and the carriage is moved by hand to set the cutting tool at the starting point of the thread. With the tool just grazing the workpiece, the split-nut lever is lowered to engage the leadscrew. This can be done at any point, **provided** the split-nut remains engaged throughout the **entire multi-pass process**.

When the first pass is completed, the tool is backed out clear the workpiece (using the cross slide), and the spindle is reversed to bring the saddle back to the starting point. The cross slide is returned to its former setting, then the tool is advanced a few thousandths by the compound for the next pass. Each successive pass is done in the same way, each with a slightly increased infeed setting of the compound.

Many users working on U.S. threads save time by disengaging the split-nut at the end of each cutting pass, reversing the

saddle by hand, then re-engaging, usually by reference to the threading dial, Figure 3-20.

If the TPI number is divisible by 2 re-engagement can be done at **any line** on the threading dial.

For all other TPI numbers every engagement, **including the first**, must at the point where a **specific line** on the threading dial comes into alignment with the datum mark. If not, the second and subsequent passes will be out of sync. In some cases, Figure 3-20, there is a choice of lines for re-engagement, but in every case the process calls for careful timing. [NOTE: Disengagement and re-engagement of the split-nut is not applicable to metric threads].

Typical depths of cut per pass vary from an initial 0.005" or so, to as little as 0.001", even less. A finishing pass or two with increments of only 0.0005" (or none at all) to deal with the spring-back effect can make all the difference between a too-tight thread and one that runs perfectly.

Assuming that the compound is set over at between 29 and

30 degrees, the total depth of cut is approximately 0.69 times the thread pitch, P (this equates to a straight-in thread depth of 0.6 times P). There may be a need for a few thousandths more in-feed than 0.69P, almost certainly not less.

USING THE THREADING DIAL

Referring to Figure 3-20, the general rules are:

1. Divide the TPI value by 2: If this gives a **whole number**, example $10/2 = 5$, re-engage at **any line** on the dial. Special case: if the result of dividing by 2 is an even number, example $12/2$, you can re-engage midway between lines.
2. If the TPI value is a whole number not divisible by 2, example 7, re-engage on the start line, or any line at right angles to it. In the table this shows as 1-3-5-7 (but could be 2-4-6-8, etc.).
3. If the TPI value is fractional, but becomes a whole number when multiplied by 2, example $4\frac{1}{2}$, re-engage only on the start line, or its diametrical opposite. In the table this shows as 1-5-1 (but could be 2-6-2, etc.).

If in doubt, re-engage on the start line!

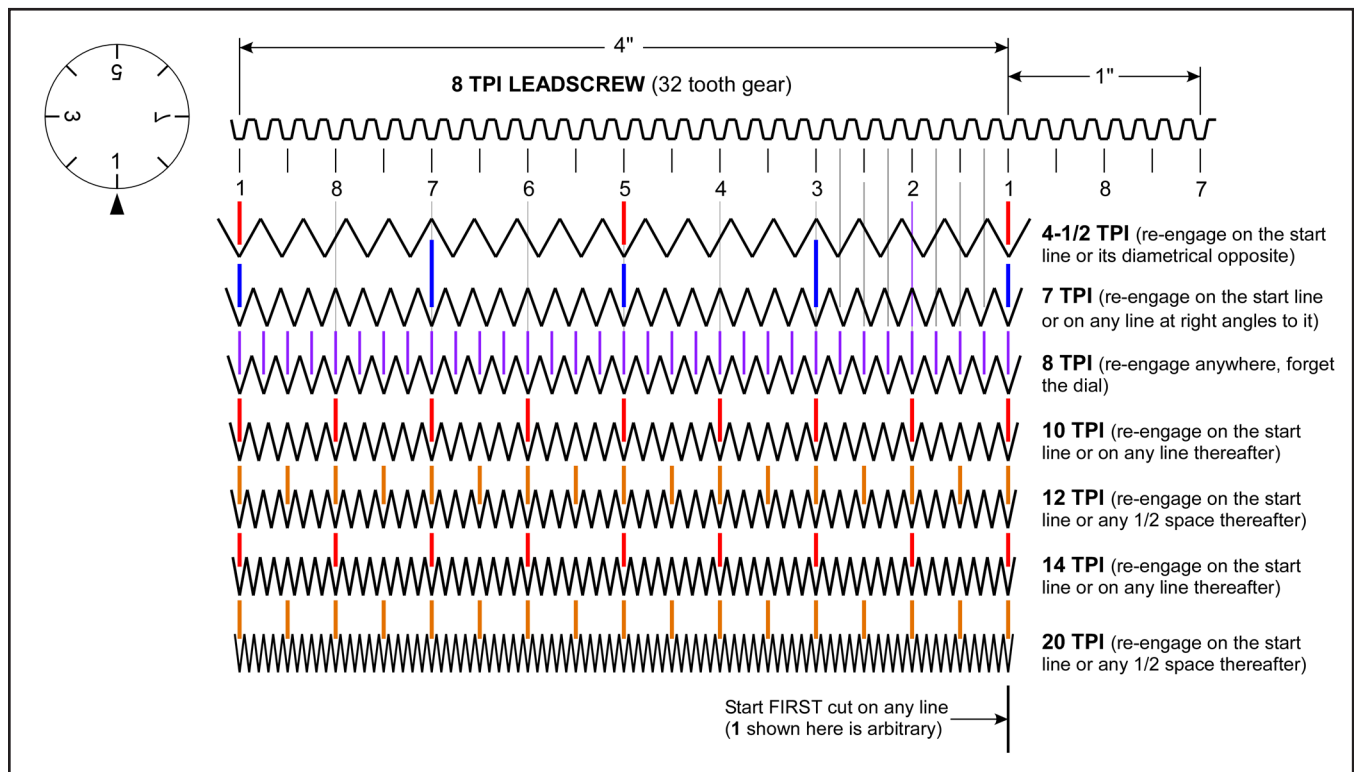


Figure 3-20 Threading dial visualization for selected U.S. threads
Minimize wear by swinging the dial indicator assembly away from the leadscrew when not in use

GAP BED

A 7-1/2 inch long section of the bed at the headstock end can be removed to allow turning of diameters up to 19-3/4 in., Figure 3-21.

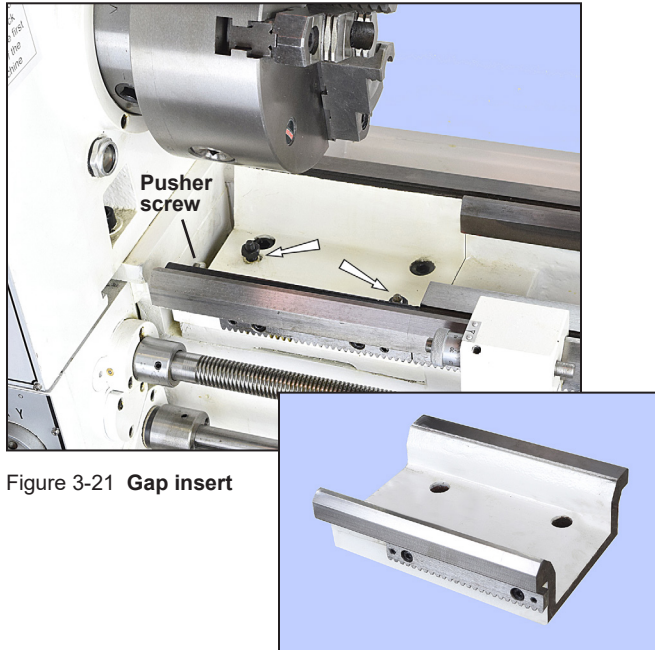


Figure 3-21 Gap insert

To remove the gap insert back in the pusher screw one or two turns, then remove the four large socket head screws securing the insert to the bed. To minimize cosmetic damage, cut through the paint and filler along the joint between insert and bed using a sharp knife or pointed scraper.

Jack out the two locating pins arrowed (exposed threads and hex nuts), then tap the insert free with a soft-face mallet.

Before re-installing the insert, be certain that all mating surfaces are scrupulously clean. Set the insert in place, lightly tap in the two locating pins, then install the four large bolts (snug, but not fully tightened). Jack the insert to the right with the pusher screw to close the gap, if any, between the ground surfaces of the bed ways at the join (a visible parting line is acceptable, but a discontinuity that snags the saddle is not). If a satisfactory join cannot be achieved, it may be necessary to remove and reinstall the insert from scratch.

LOCKING THE SLIDES

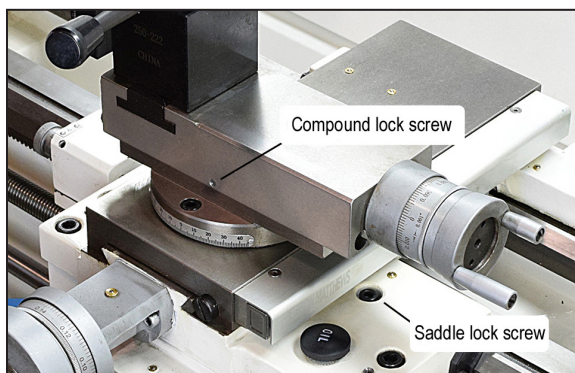


Figure 3-22 Compound & saddle locks

When face-cutting large diameter surfaces, for instance, it is often desirable to lock the saddle. Less frequently it can be helpful to lock, or at least stiffen, sliding motion of the compound, Figure 3-22.

Access to the saddle lock screw may be limited by the DRO scale cover. If so, it may be desirable to replace the installed screw (socket head) with a conventional hex head, or a ratcheting lever screw.

STEADY & FOLLOWER RESTS

The hinge-type steady rest, Figure 3-23, can be mounted anywhere along the lathe bed. It makes possible cutting operations on long, slender workpieces between centers, or held at one end by chuck. The steady rest is often used in combination with the saddle-mounted follower rest, Figure 3-24.

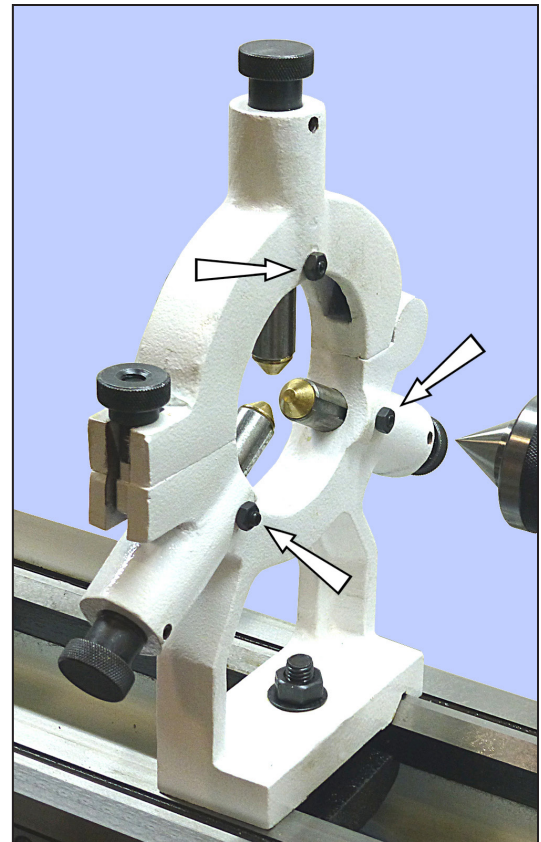


Figure 3-23 Steady rest (representative)

To set the fingers on the workpiece, first swing open the upper casting. Make certain that all three fingers are freely adjustable by thumbwheel. If not, loosen and re-lock the set screws (arrowed). Raise the two lower fingers to just touch the workpiece — not deflecting it — then close and secure the upper casting. Lower the top finger to just touch the workpiece, clamp the frame, then apply oil at the point of contact.

The follower rest, Figure 3-24, is secured to the saddle with two 8 mm socket head screws. Adjust the follower fingers as described for the steady rest.

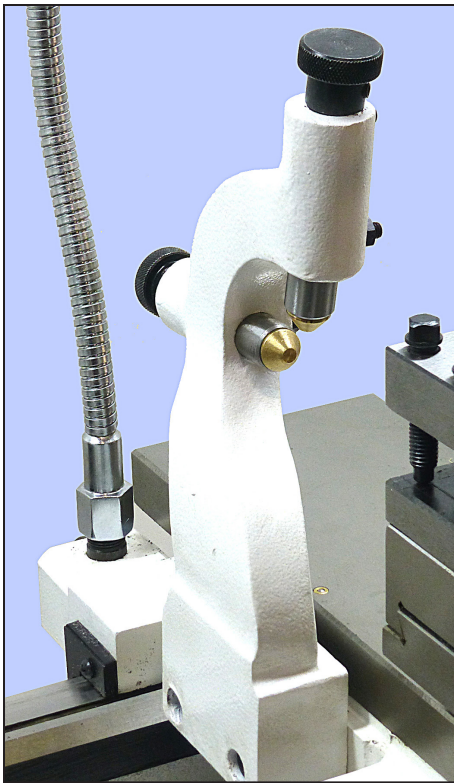


Figure 3-24 **Follower rest** (representative)

SPIDER

A spider is installed on the left hand end of the spindle. Its function is to stabilize long workpieces that would otherwise wobble. To set up the spider, back out its four clamp screws, then chuck the workpiece using moderate jaw pressure. The aim is now to match runout at the spider end with runout at the chuck end (usually adjusted for zero unless a deliberate offset is called for). Progressively tighten the spider clamp screws to grip the workpiece firmly, without deflecting it.

Re-check runout at the chuck end, correcting one or more of the spider screws if necessary. Fully tighten the chuck. Some amount of iteration may be necessary to achieve similar runout at both ends. When satisfied with the setup, **fully tighten** the locknuts on the spider screws, then re-check.

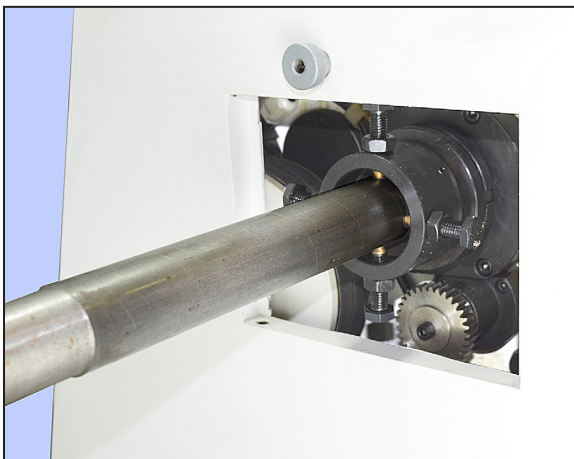


Figure 3-25 **Spider attachment**

COOLANT SYSTEM

The coolant system is typically used with water-miscible (emulsified) cutting fluid. It can also be used with lightweight neat cutting oil straight from the can. Synthetic cutting fluids are not recommended due to their potential for corrosion and other undesirable effects on the lathe and the coolant pump.

If you use water-miscible cutting fluid, bear in mind that the ratio of product to water is important — too much water causes excessive corrosion and other problems. Check the mix from time to time using a refractometer. If this is not available, make up a small batch according to the product directions, then replace with a fresh batch when the old one becomes unusable due to reduced performance, oil/water separation, or bad odor.

Disposal of used cutting fluid can be a problem. It is about 95% water, so its volume can be drastically reduced by evaporation in an open tank. The residue may then be handled like any other waste oil.

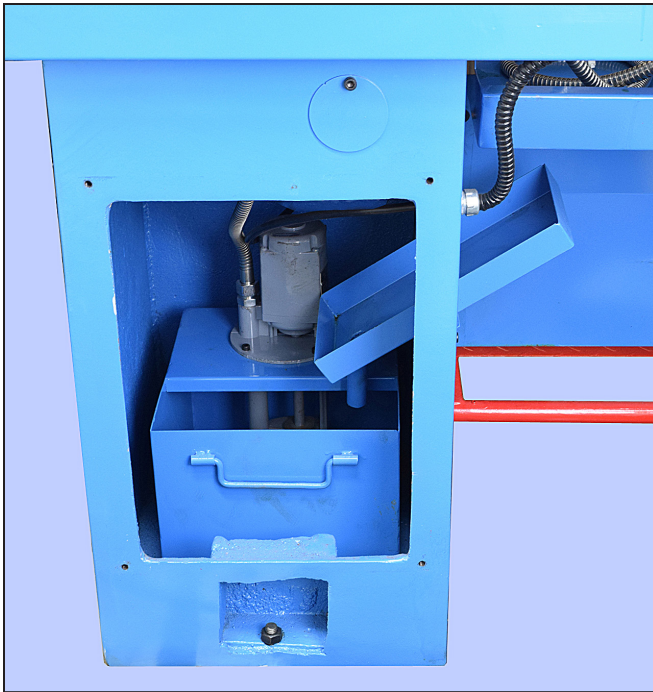


Figure 3-25 Coolant pump assembly, RH stand cabinet

Section 4 SERVICING THE LATHE



Disconnect 220V power before any maintenance operation!



Remove all machining debris and foreign objects before lubricating ANYTHING! If need be, any oil is better than no oil – but use the recommended lubricants when you can.

GENERAL

Aside from abrasive particles and machining debris, lack of proper lubrication is the main cause of premature wear. Rotating parts are easy to lubricate, sliding parts are not. Gibs are tightened for the best compromise between rigidity and slideability, which means practically zero gap between the ways. It is not obvious which are the bearing surfaces on the various dovetail surfaces — some of the interfaces look like bearing surfaces, but are simply narrow gaps.

Every few hours of operation: 1. Apply the recommended way-oil with a dedicated short-bristle brush such as the type used for applying flux; 2. Use a similar brush to apply oil or grease to the leadscrews; 3. Apply oil to the ball oilers, see below.

The spindle runs on sealed, pre-lubricated roller bearings requiring no routine attention.

Recommended lubricants

Gearboxes: ISO 68, such as Mobil DTE Heavy/Medium circulating oil. Approximate quantities required:

Headstock 4 quarts

Saddle feed gearbox 2 quarts

Apron 1 quart

Ball oilers: ISO 68 way oil, such as Mobil Vactra No. 2, or equivalent.

Machine ways (dovetails): ISO 68 way oil, such as Mobil Vactra No. 2, or equivalent.

External change gears: light general purpose grease, NLGI No. 2, or equivalent.

Leadscrews: ISO 68 way oil, such as Mobil Vactra No. 2, or equivalent.

BALL OILERS

Use a pump-type oil can, preferably with a flexible spout tipped with a soft tube. The ID of the tip should be large enough to seat on the oiler's brass flange, more than spanning the spring-loaded steel ball. When the oil can tip is firmly pressed onto the brass surface oil pressure will displace the ball, allowing oil to flow into the bearing. Before oiling check that the ball is not stuck – press it lightly with a probe.

HEADSTOCK GEARBOX DRAIN & REFILL

Take time to prepare. 4 quarts is a lot of oil to clean up!

1. Remove the belt cover, left of the headstock.
2. Remove the fill plug on the top surface of the headstock, Figure 4-1.

3. Place a drain pan (2-gallons minimum) on a stool or other support at about the height of the chip tray.
4. Fold a sheet of card stock to make a Vee-shape drain channel. This will be pressed against the headstock below the drain plug, angled downward into the drain pan; trim the upstream end of the Vee so that it seals against the headstock.
5. Run the lathe a few minutes to warm the oil if necessary.
6. With the drain channel in place, remove the drain plug, Figure 4-2.
7. Allow the oil to drain completely. Replace the drain plug, then add just a few ounces of oil.
8. When satisfied that the headstock is oil-tight, add oil to the halfway mark on the sight glass (about 4 qts).
9. Replace the fill plug.

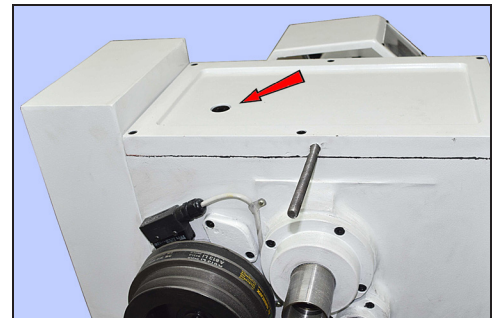


Figure 4-1 Headstock fill plug (representative)

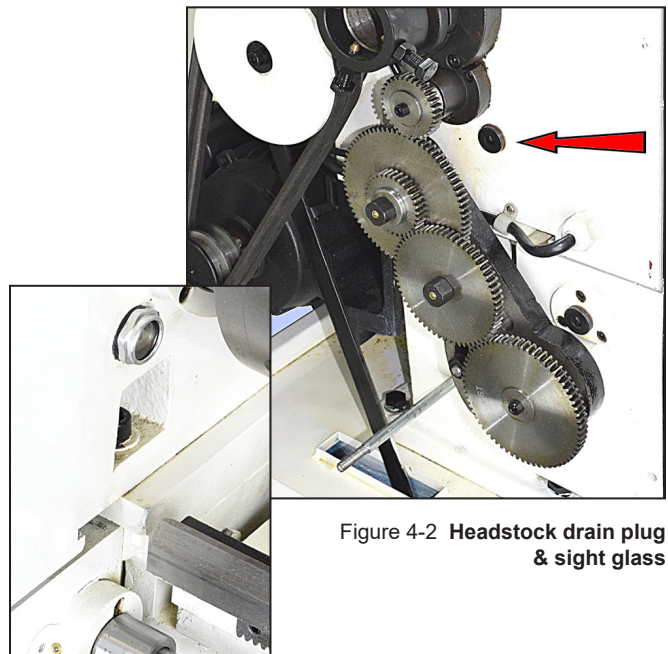


Figure 4-2 Headstock drain plug & sight glass

SADDLE FEED GEARBOX DRAIN & REFILL

Make a card-stock Vee channel as described for draining the headstock. Remove the gearbox fill plug, Figure 4-3. Remove the gearbox front panel to expose the drain plug, Figure 4-4. Run the lathe for a few minutes to warm the oil if necessary. With the Vee channel in place, remove drain plug and allow the gearbox to empty completely. Replace the drain plug. To refill the gearbox use a funnel attached to a flexible plastic tube inserted into the fill hole. Add oil to the halfway mark on the sight glass (about 2 qts).

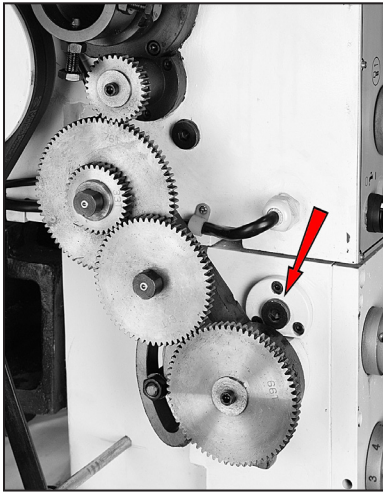


Figure 4-3 Saddle feed gearbox fill plug

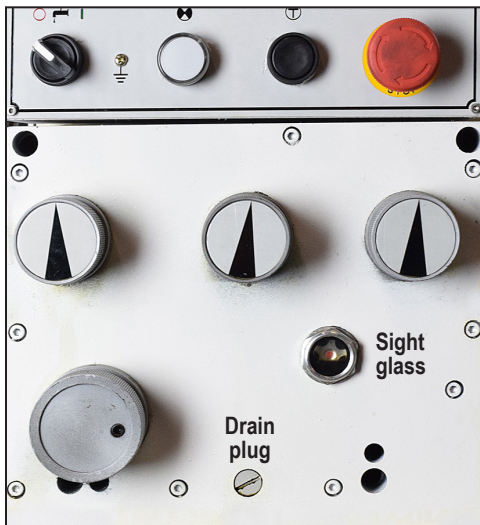


Figure 4-3 Saddle feed gearbox sight glass & drain plug
Cover plate removed

APRON GEARBOX DRAIN & REFILL

Remove the fill plug, Figure 4-4. Remove the drain plug, and allow the apron to empty completely. Replace the drain plug. Add oil to the halfway mark on the sight glass (about 1 qt).

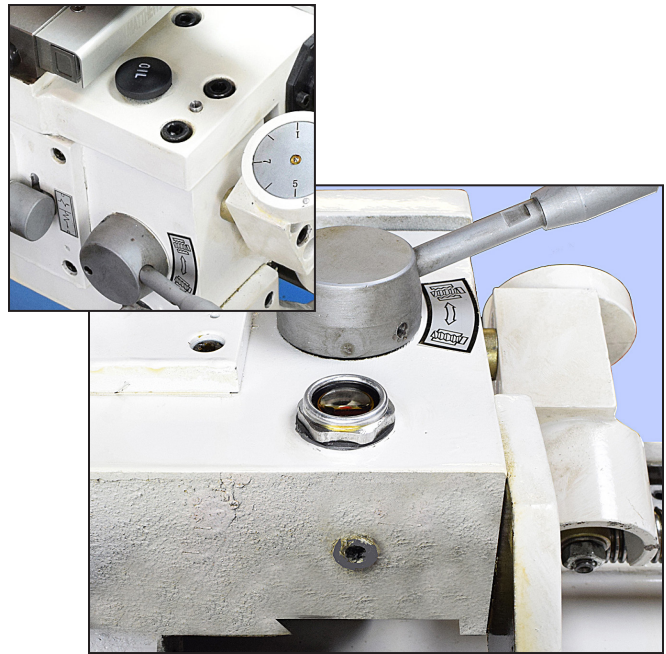


Figure 4-4 Apron gearbox fill plug, drain & sight glass

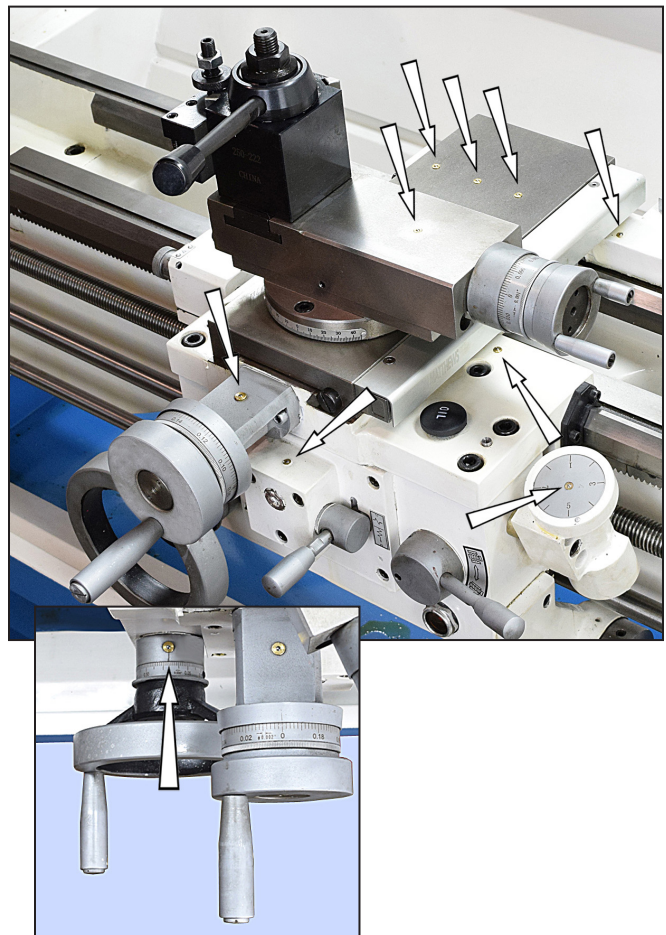


Figure 4-6 Saddle, cross slide and compound oilers

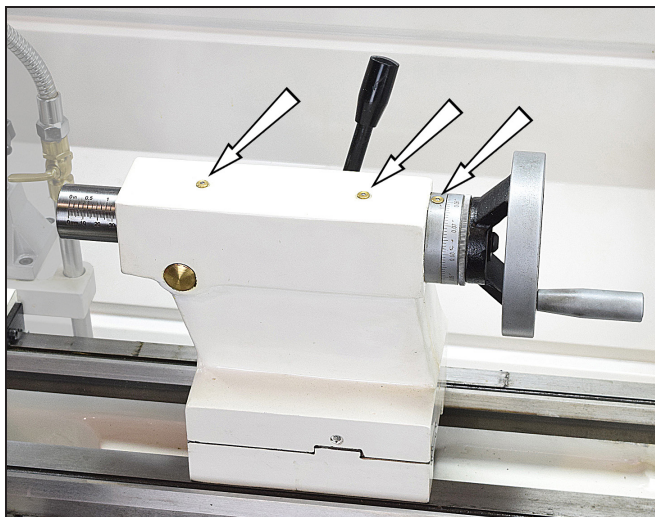
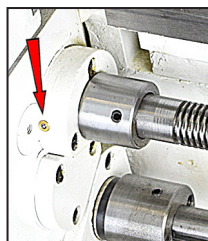


Figure 4-8 Tailstock oilers



Leadscrew oiler at headstock end

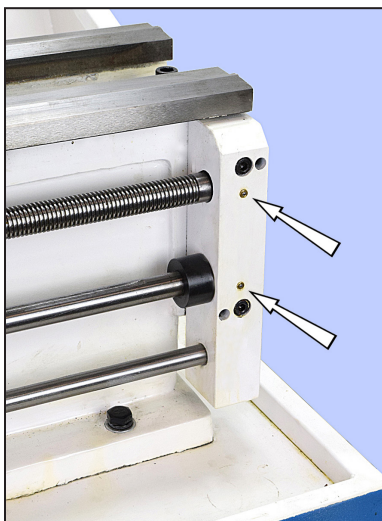


Figure 4-7 Leadscrew and feed shaft oilers

Oilers that are easy to forget ...

! Remove the belt cover left of the headstock for access to the external change gears. There are ball oilers on the two intermediate gear spindles.

GIB ADJUSTMENT

Gibs on the cross slide and compound are gently-tapered lengths of ground cast iron held fast by opposing screws at each end (Figure 4-9 shows only the screw facing the hand-wheel). Adjusting them is a trial and error process that takes time and patience. Aim for the best compromise of rigidity and reasonably free table movement. Too tight means accelerated wear on the ways and leadscrews. Too free means instability of the cutting tool, inaccuracies and chatter.

Both screw heads must be tight against the gib ends. If you loosen one, tighten the other.

The carriage, Figure 4-10, is not a tapered insert like those on the cross slide and compound. It is a three-part assembly on the underside of the bed way at the back of the lathe. It comprises a support bar, attached to the carriage, and two separate gib strips each with two adjusting screws.

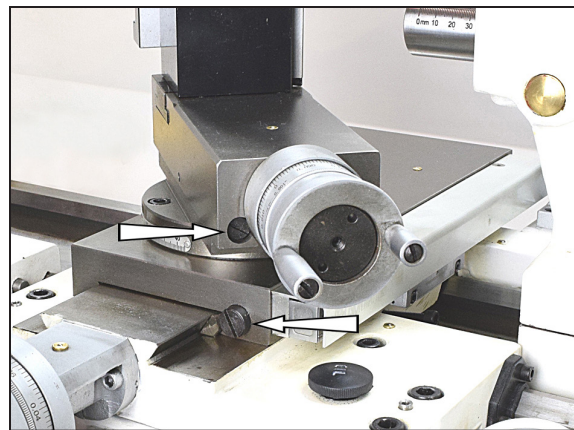


Figure 4-9 Cross slide and compound front gib screws

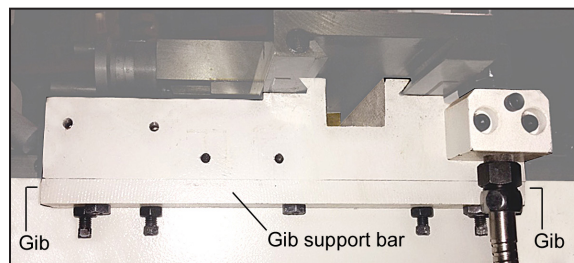


Figure 4-10 Saddle gib at back (representative)

SPLIT NUT ADJUSTMENT

In screw-cutting operations, if the split nut becomes excessively loose — appreciable side to side movement — this may be corrected by adjusting the gib at the right side of the apron. Remove the threading dial. Loosen the locknuts securing the three screws in Figure 4-11, tighten the screws as necessary, then re-lock.

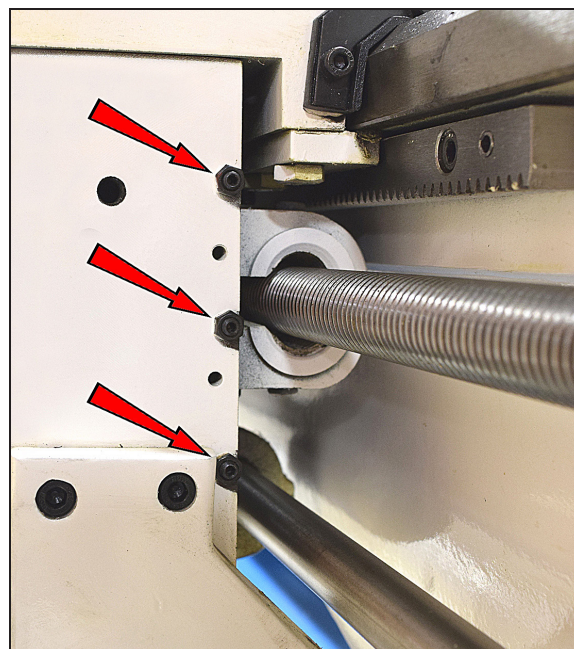


Figure 4-11 Split nut gib screws

CROSS-SLIDE & COMPOUND BACKLASH

When alternating between clockwise and counter clockwise rotation, the cross-slide handwheel may move freely a few degrees but the cross-slide table stays put. There may also be similar lost motion in the compound. The acceptable amount depends on the user, but 0.005" is generally a good compromise. Smaller numbers are possible, but overdoing it can lead to premature wear of leadscrew and nut.

Lost motion is due to two factors: 1. End-float (in/out movement of the handwheel) caused by insufficiently tight coupling of the leadscrew and thrust bearings. 2. Wear in the leadscrew nut.

Factor #1 is correctable in both the cross-slide and compound.

Leadscrew handwheels on the PM-1440GS — cross-slide, compound and tailstock — are attached in a similar way, Figure 4-13. The handwheel is locked to the leadscrew shaft by a key (not shown). It is held in place by a flange screw in a threaded well at the outer end of the leadscrew shaft. An internal locking set screw, bottomed in the well, prevents loosening of the flange screw. To correct backlash due to loose coupling between leadscrew and thrust bearings, back out the set screw a turn or two, then tighten the flange screw using a pin vise or needle-nose pliers. Do not tighten to the point where the thrust bearings are over-compressed, resulting in uneven motion. Back off for smooth rotation, with no appreciable end-float. Re-tighten the set screw. This tends to back out the handwheel a small amount, so check end-float again.

Factor #2 is correctable in the cross-slide by compressing the leadscrew nut, Figure 4-14. Remove the compound from the cross-slide, then remove the socket head screw securing the cross-slide to the leadscrew nut. Turn the cross-slide handwheel clockwise to drive the nut backward until it can be worked on at the back. If not already installed insert an M6 x 1 socket head screw, approximately 15 mm long, then tighten the screw as necessary. Don't overdo this — a 45 degree turn of the screw represents a backlash take-up of about 0.005".

The compound leadscrew nut is not adjustable.

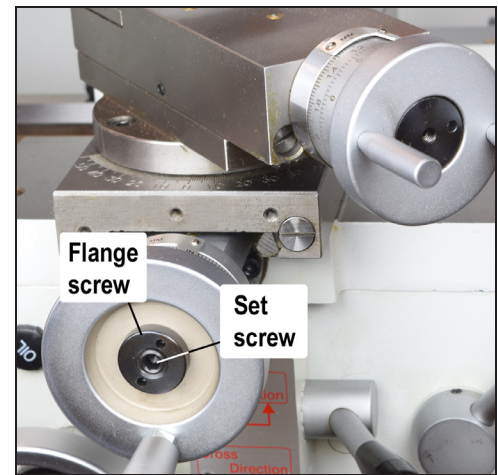


Figure 4-13B Handwheel attachment

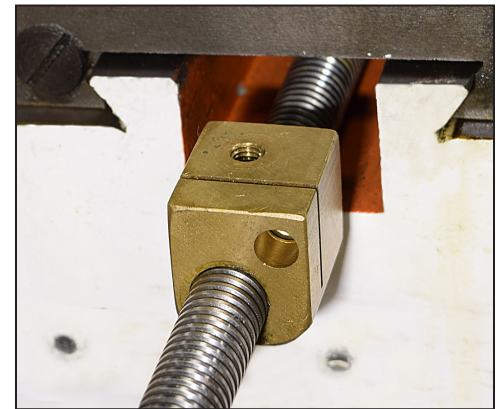


Figure 4-14 Cross slide leadscrew nut (representative)

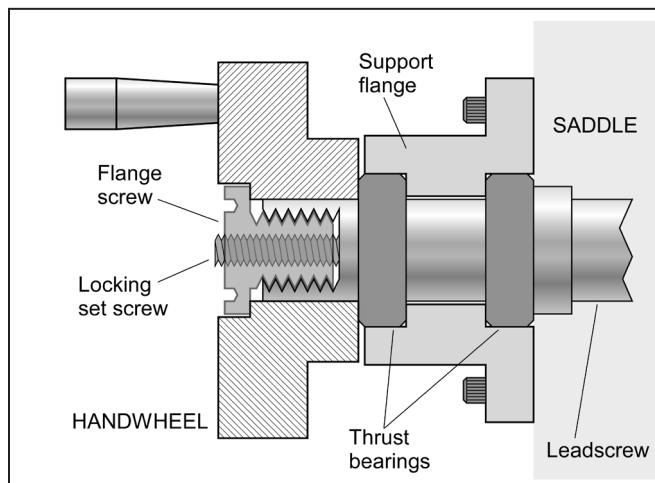


Figure 4-13A Handwheel attachment schematic

BRAKE ASSEMBLY

The treadle-operated brake does two things: 1. It disconnects power from the motor, and; 2. It expands brake shoes against the hollowed-out inboard face of the driven pulley.

Inspection of the brake assembly, Figure 4-13, calls for person A to lock the driven pulley while person B removes the socket head screw securing the driven pulley.

The inboard face of the driven pulley (the brake drum) should show no gouging or irregularities. Minor damage may be correctable by skimming; otherwise consider replacing the item.

The brake pads should be clean, evenly worn, showing no sign of oil. Minimum pad thickness is 4.5 mm, about 0.18". If necessary replace the pads by separating them — extending the springs — then lifting them clear of the retaining studs.

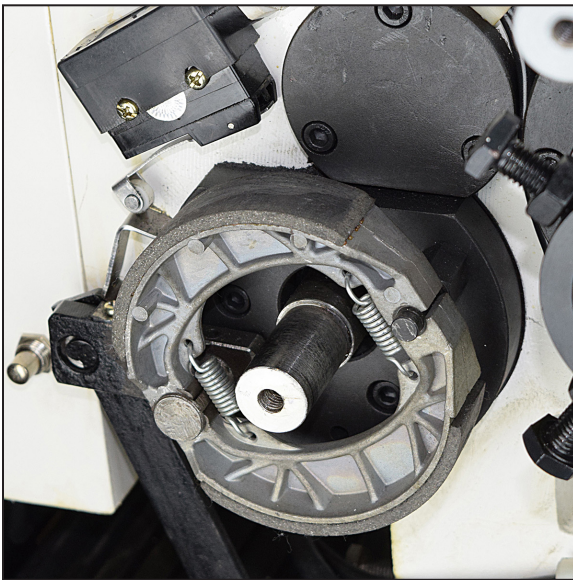


Figure 4-13 **Brake assembly**

TAILSTOCK BED CLAMP

The angular position of the bed clamp lever is adjustable. Slide the tailstock toward the headstock to expose the threaded stop screw at the right hand end of the bed. Remove the stop screw, then **very carefully slide** the tailstock to the right, just far enough to allow access to the hex nut below the tailstock bed plate. Tighten the nut as necessary.

ALIGNING THE LATHE

The most important attribute of a properly set up lathe is its ability to “machine parallel”, to cut a cylinder of uniform diameter over its entire length. In other words, no taper.

Leveling of the lathe is a part of this, see Section 1. Equally important is the alignment of the center-to-center axis with the lathe bed, as seen **from above**. [Vertical alignment is nowhere near as critical, rarely a cause of taper unless the lathe is damaged or badly worn.]

How to align lathe centers

Practically all lathes come with some means of offsetting the tailstock, typically for taper turning. For routine operations, the offset must be zero, Figure A.

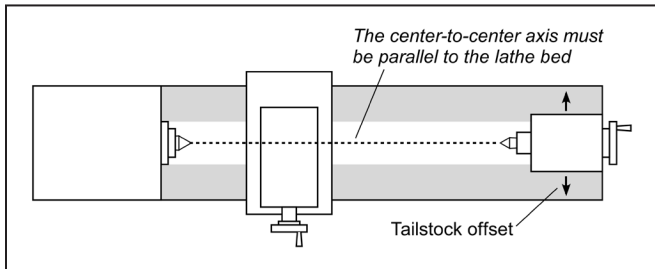


Figure A Center-to-center axis

The scale provided on the tailstock is not reliable for precision work — think of it as only a starting point. What follows are two methods for aligning centers, one quick and easy, the other more precise.

Quick method

This method works only if the centers are in new condition, sharp and clean.

1. Carefully clean the taper sockets and the tapers themselves. Install the tapers.
2. Move the saddle left as far as it will go, then slide the tailstock left to touch the saddle.
3. Lock the tailstock (this is important — unlocked to locked can mean an offset of several thousandths). Try to use the same locking force every time you move the tailstock.
4. Advance the tailstock quill to bring the centers together.
5. Place a scrap of hard shim stock or an old-style double-edge razor blade between the centers, Figure B.
6. Advance the tailstock quill to trap the blade, then lock the

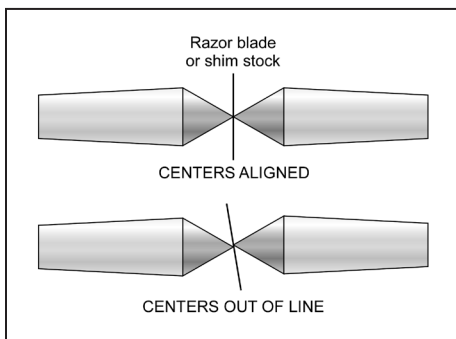


Figure B Quick alignment check

quill. If the centers are aligned, the blade will point squarely front to back. If not, adjust the tailstock offset by a series of very small adjustments.

7. If the range of quill motion permits, check the blade alignment at various extensions of the quill. There should be no appreciable variation.

Precise method

This method uses a precision ground steel rod at least 10" long. Look for 3/4 or 1 inch "drill rod" with a diameter tolerance of ± 0.001 " or less.

Straightness and uniform diameter are both important (absolute diameter is not).

1. Set the rod in a collet chuck, or independent 4-jaw chuck, with the outer end about 1/2 inch clear of the chuck.
2. Use a dial indicator to check for runout. If using a 4-jaw adjust as necessary for minimum TIR (aim for 0.0005" or less).
3. Center-drill the end of the ground rod.
4. Reverse the rod, re-adjust for minimum TIR, then drill the other end.
5. Set the drill rod snugly between centers, as Figure C. Lock the tailstock.
6. Set a dial indicator on the cross slide (to eliminate vertical error use a flat disc contact, not the usual spherical type — if a disc contact is not available, machine a cap to fit over the spherical point).
7. Starting at location (1), note which way the pointer rotates when the cross slide is moved inward. In this setup the pointer is assumed to turn clockwise as the cross slide moves in.
8. Pre-load the indicator by a few thousandths, then traverse the saddle from end to end. In a perfect the setup the pointer will not move at all.

If the pointer turns clockwise as you go toward the tailstock, as Figure C, the tailstock is biased to the front. This will cause the lathe to cut a tapered workpiece with the larger diameter at the headstock end. Correct this by a series of **very small** adjustments to the tailstock offset.

Another important question has to do with headstock/spindle alignment relative to the lathe bed. For turning **between centers** this hardly matters at all; the headstock can be wildly out of square, Figure D, but the lathe will still machine parallel if the centers have been aligned as previously described.

When headstock alignment really matters

While headstock alignment may not matter much for center turning, it is **critical** when the workpiece is held in a chuck or a collet — often about 90% of the workload in a typical model shop. Assuming no appreciable deflection of the workpiece (too thin, too far from the chuck), taper problems in a chuck/collet setup are due to misalignment of the spindle axis relative to the lathe bed. This is usually correctable by re-aligning the headstock.

Misalignment of the spindle by even the smallest fraction of a degree causes a very measurable taper, even over short lengths of material. For example, a misalignment as small as **one hundredth of a degree** will give a taper of 0.001" in 3 inches. If the headstock is (say) 10 inches long, this would be

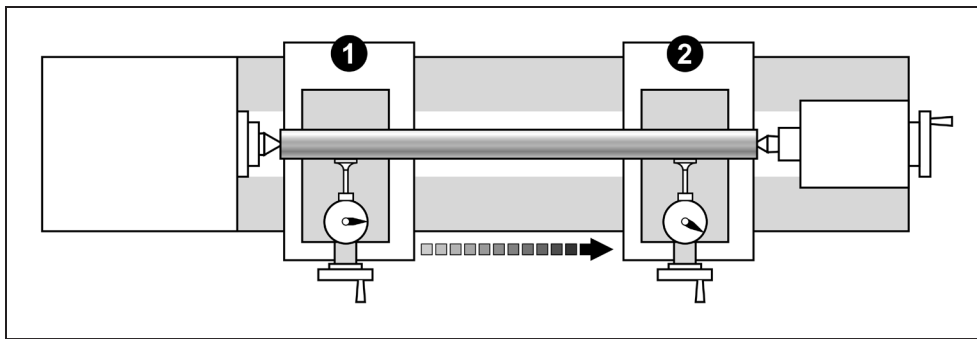


Figure C Drill rod between misaligned centers

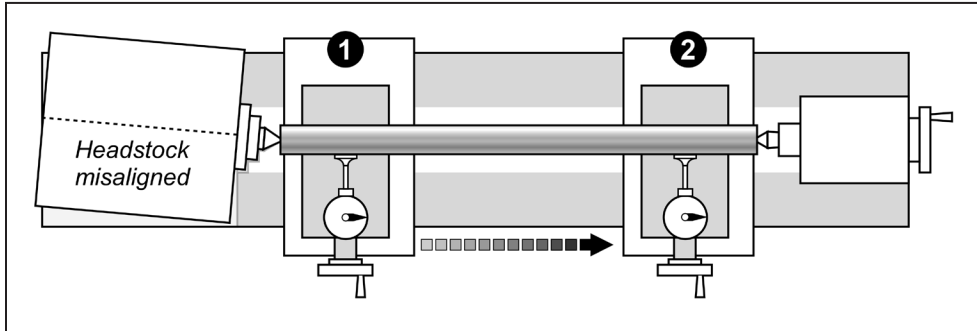


Figure D If the centers are properly aligned, as here, headstock misalignment has little effect on center turning

corrected by tapping one end of the headstock forward or back by as little as 0.002", a tiny amount even if jacking screws are provided. What this amounts to is that headstock adjustment is a **highly sensitive, iterative procedure** that should not be attempted casually. What follows is a general outline. Specific instructions for the PM-1440E-LB follow this section.

HEADSTOCK ALIGNMENT METHODS

Method 1

Make a series of "cut-and-try" passes on scrap material. If the workpiece is thinner at the tailstock end, the headstock needs to be pivoted away from the tool, and vice versa.

Method 2

This uses the 3/4 or 1 inch ground drill rod described in "Precise method" above for center-to-center alignment.

Install the drill rod in a collet or independent 4-jaw chuck with about 5 inches protruding, Figure E. Center drilling is not needed.

1. Adjust the chuck for minimum runout at position (1).
2. Check the runout at (2). Pointer movement when traversing

is not a concern at this stage.

3. If the drill rod is perfectly aligned with the spindle axis, there should be no difference in TIR at (1) and (2).
4. If there is a **significant difference in TIR*** from (1) to (2), try to correct this by loosening, then re-tightening the chuck/collet, while levering the outer end of the rod (gentle tapping with a non-marring hammer can also be helpful). When the runout at (2) has been minimized, re-check at (1), then repeat at (2), etc.
5. When (and only when) the TIR at both locations is the same, or very close, can it be said that the rod is concentric with the spindle.
6. Compare dial indications when traversing from (1) to (2). Ideally, there will no change.

* Factors that may affect runout

Straightness and roundness of the drill rod; Chuck installation (check for cleanliness and tightness); "Pointing accuracy" of the chuck (the gripping surfaces of chuck jaws may not be parallel with the axis of the chuck and spindle — especially likely if the chuck is worn).

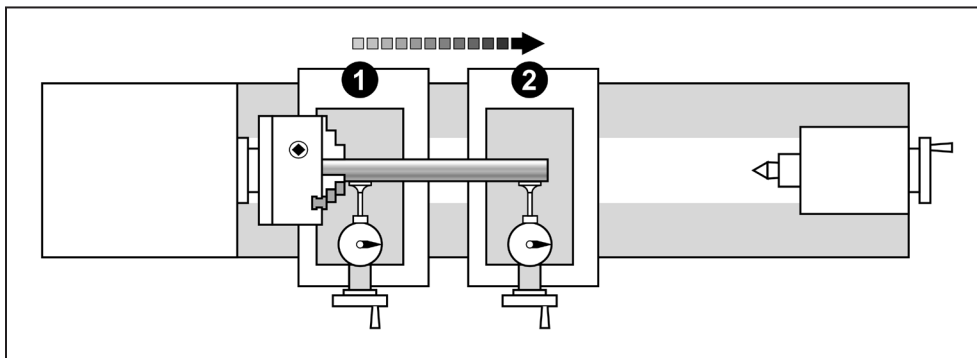


Figure E Perfect alignment: zero indicator change between locations 1 and 2

Method 3 - Morse Taper Test Bar

This is a catalog-only item available from many suppliers (depending on the source it may be named differently). The test bar in Figure F has a tapered shank to fit the spindle, and a parallel portion several inches long. The diameter of the parallel portion is unimportant. What matters more is its finish and lack of taper— check before installing. Whatever taper there may be can be allowed for in the alignment test, as Figure E. Runout should be less than 0.0005" TIR.

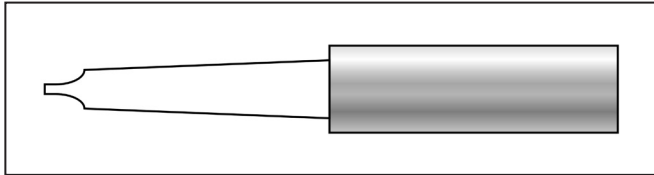


Figure F Morse taper test bar

PM-1440GS HEADSTOCK ALIGNMENT

Figure A1 is an exaggerated top-down view of what happens if the spindle is not precisely aligned with the lathe bed. This is correctable by *slightly* loosening the attachment screws, Figures A2 and A3, then adjusting the screws set into a tab rail below the headstock, Figure A4.

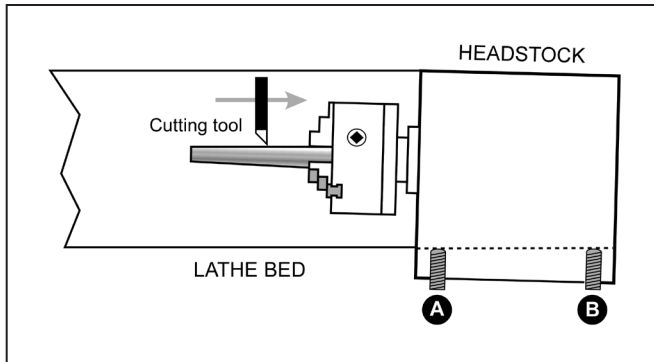


Figure A1 Misaligned headstock

In this illustration the workpiece diameter increases as the cutting tool moves toward the chuck. Correct this by screwing in (A) a fraction of a turn to rotate the headstock counter clockwise, moving the workpiece away from the tool. Screw in (B) if the taper is in the other direction, thinner toward the chuck.

CAUTION!

Correcting headstock misalignment is a multi-step process requiring a number of **extremely small adjustments**, each one followed by an alignment test, either cut-and-try, or one of the other methods previously described.

A scarcely detectable rotation of an adjusting screw can be the difference between perfect alignment and unacceptable taper. In other words, think in terms of thousandths of an inch or less. Simply loosening the socket heads, Figure A4, can be enough to correct a taper problem — or add to it in the wrong direction.



Figure A2 Headstock attachment screws, RH

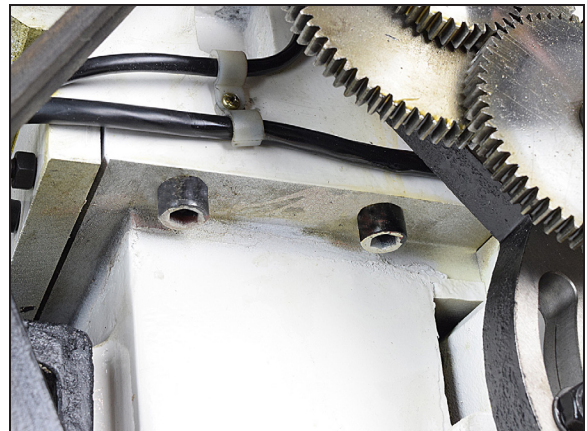


Figure A3 Headstock attachment screws, LH

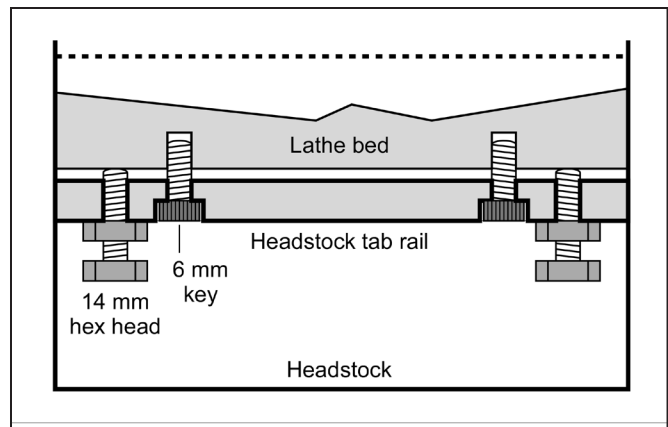


Figure A4 Adjustment screws below the headstock
The recessed socket head screws lock the adjustment by pulling the tab rail toward the lathe bed. Loosen the socket heads a fraction before touching the hex heads.

PM-1440GS HEADSTOCK ALIGNMENT

Figure A1 is an exaggerated view of what happens if the spindle is not precisely aligned with the lathe bed. This is correctable by **slightly** loosening the attachment screws, Figures A2 and A3, then adjusting the screws set into a tab rail below the headstock, Figure A4.

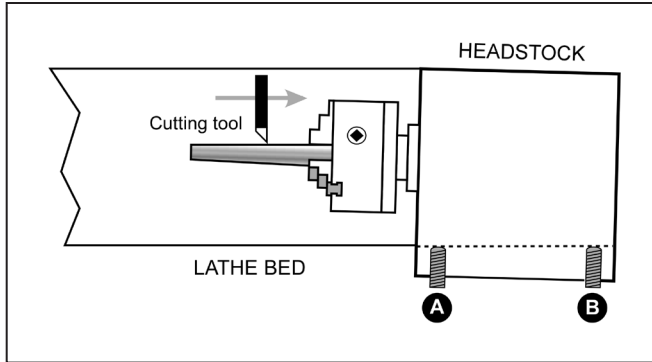


Figure A3 **Misaligned headstock**

In this illustration the workpiece diameter increases as the cutting tool moves toward the chuck. Correct this by screwing in (A) a fraction of a turn to rotate the headstock counter clockwise, moving the workpiece away from the tool. Screw in (B) if the taper is in the other direction, thinner toward the chuck.



Figure A2 **Headstock attachment screws, RH**

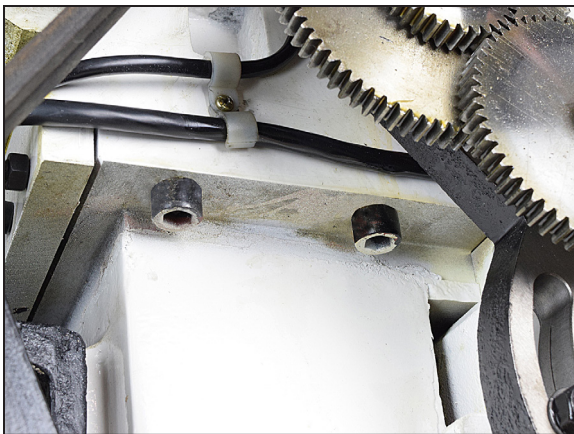
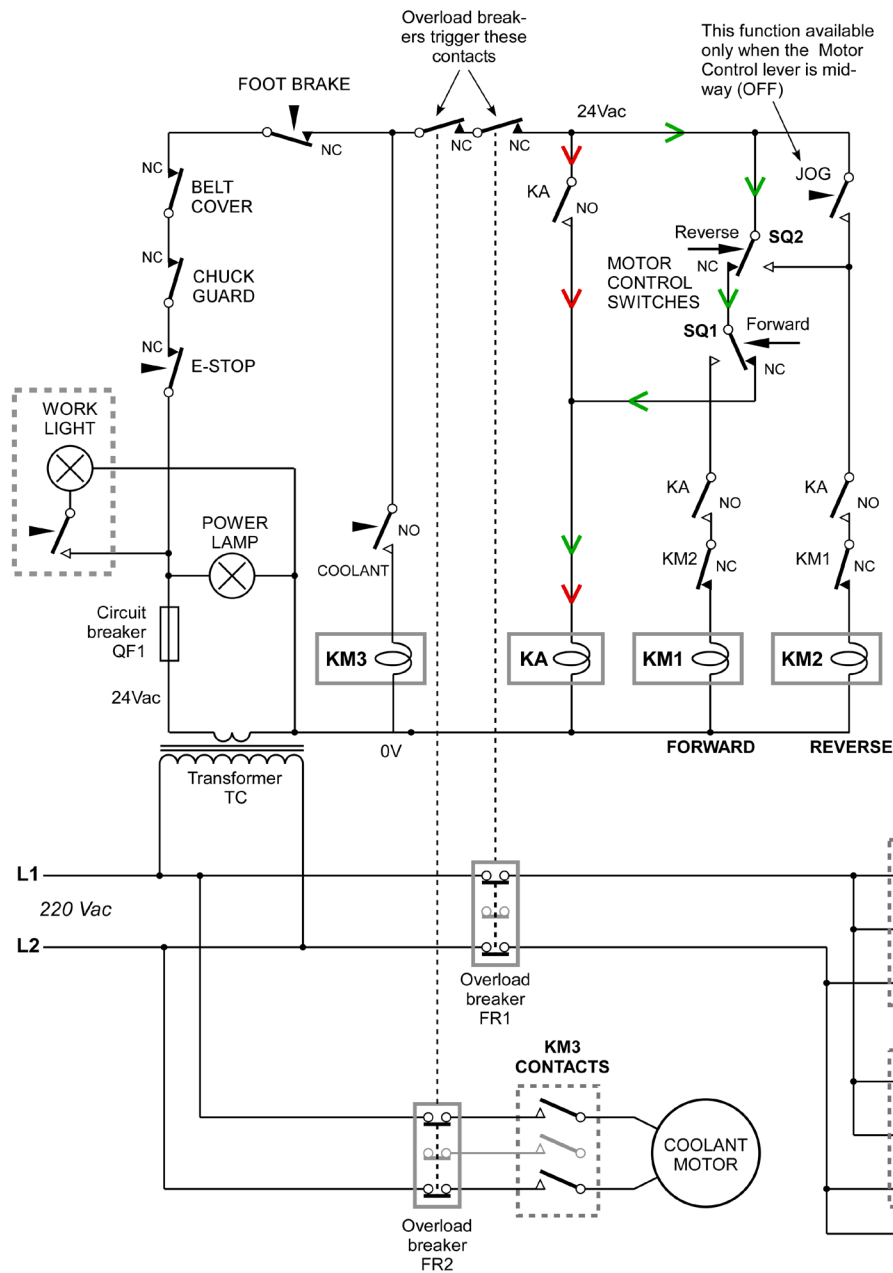


Figure A3 **Headstock attachment screws, LH**

Section 5 PARTS

This schematic is a functional diagram. It is representative only, and does not depict physical point-to-point wiring.



When pushed, the Emergency (E-STOP) button disconnects power. The "E" button remains in until reset by twisting action.

In addition to the E-STOP button, for electrical continuity the Chuck Guard and Belt Cover must also be closed and the Foot Brake released.

Contactor KA is the power-switching (enabling) relay. If, and only if, the Motor Control lever is midway = OFF (switches SQ1 and SQ2 as shown here), KA will be energized through the "initial" path (green arrows) when the lathe is powered up. After that, KA is self-maintaining: one of its contacts keeps the coil energized through the "maintain" path (red arrows), bypassing SQ1 and SQ2.

Other contacts of KA enable the motor-controlling contactors KM1 and KM2, making it possible for one or the other to be energized when the Motor Control lever is moved DOWN (Forward, KM1), or UP (Reverse, KM2).

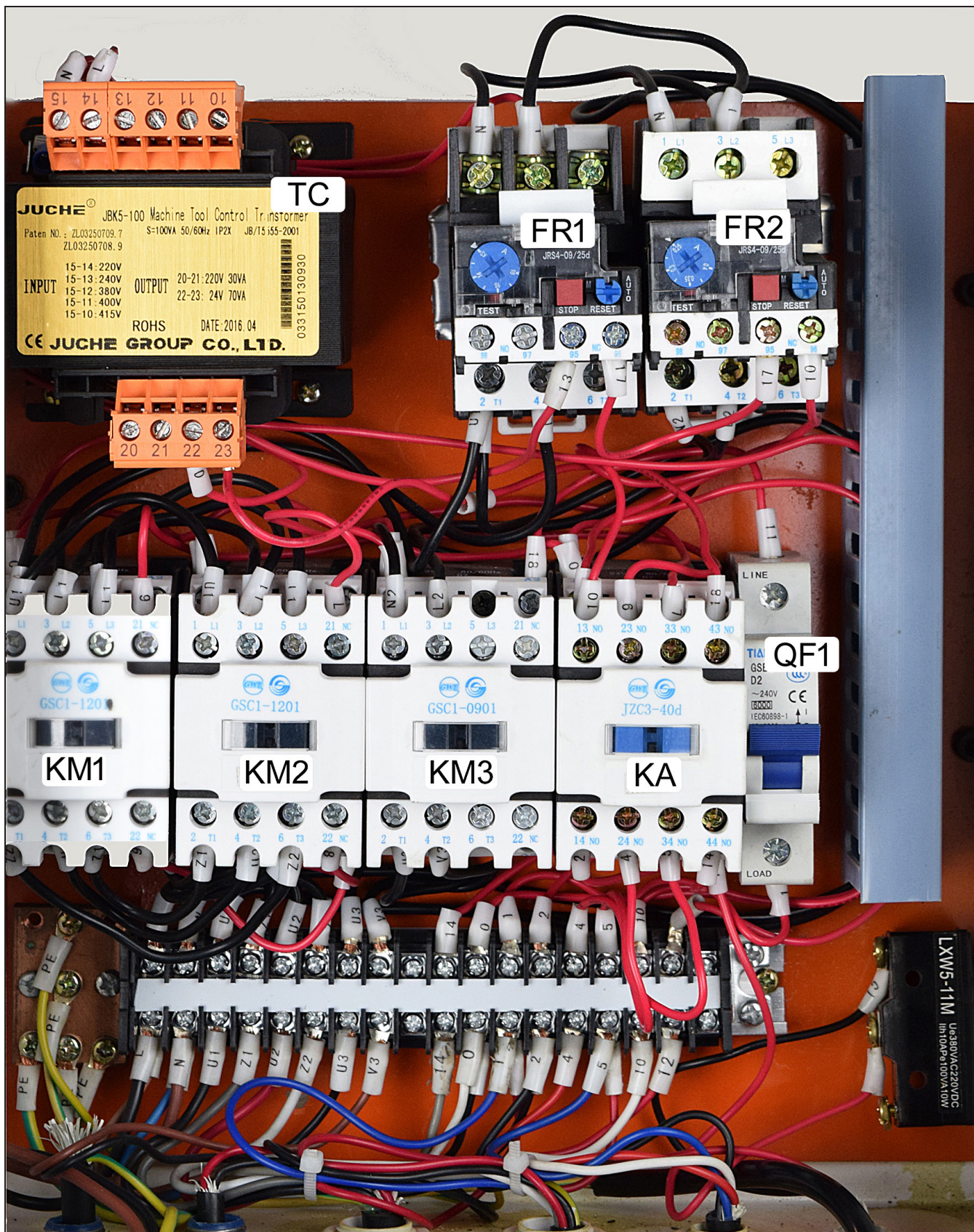
NC = normally closed
NO = normally open

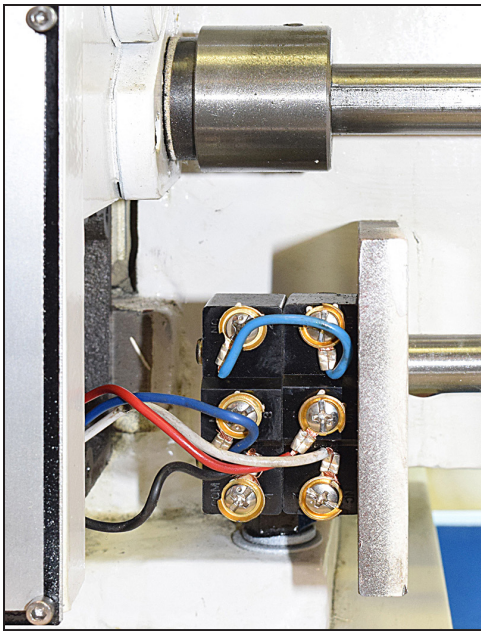
L1, L2 may be marked L, N

LOW VOLTAGE, CONTROL

HIGH VOLTAGE, POWER

PM-1440GS ELECTRICAL SCHEMATIC



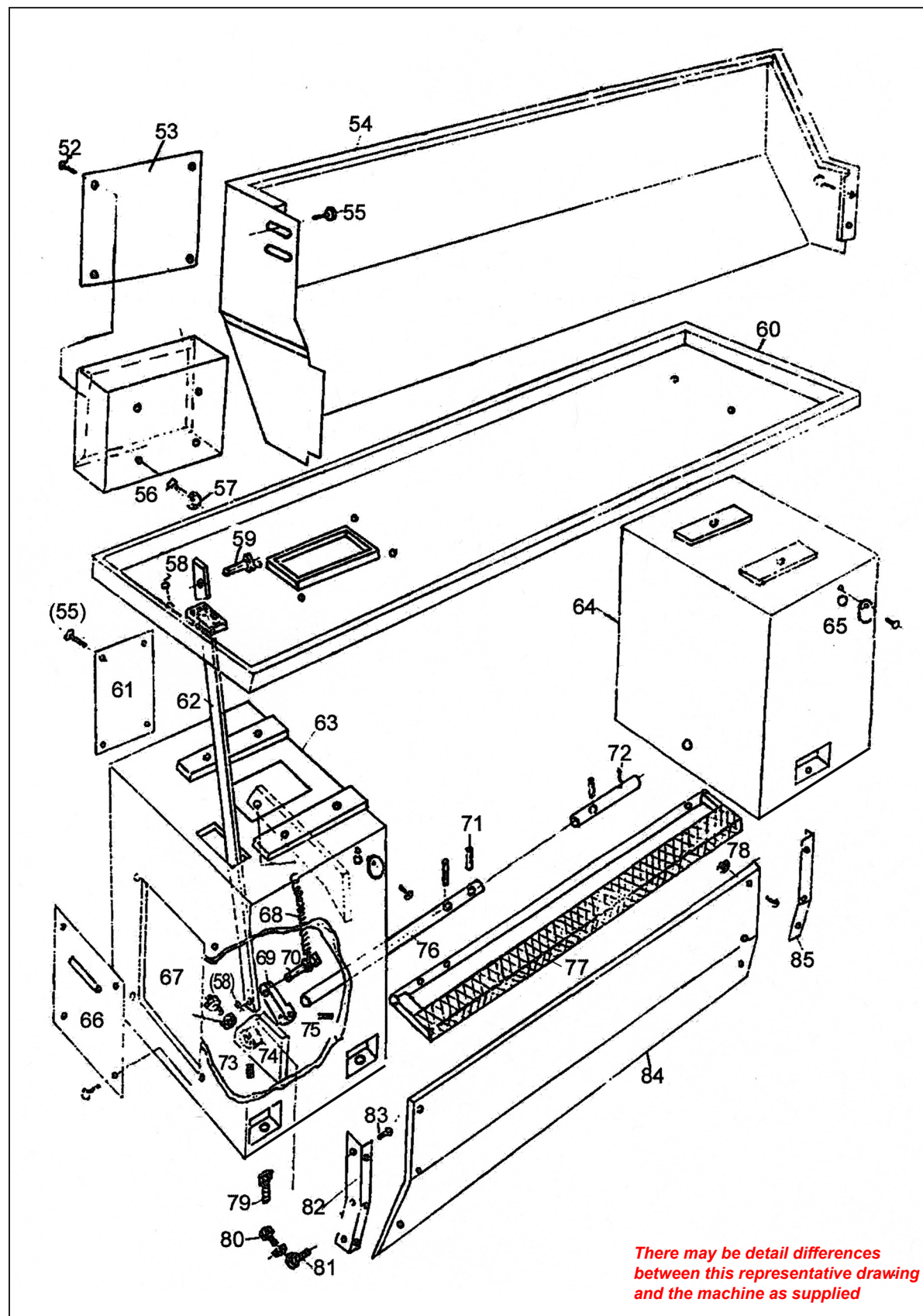


Motor control switches

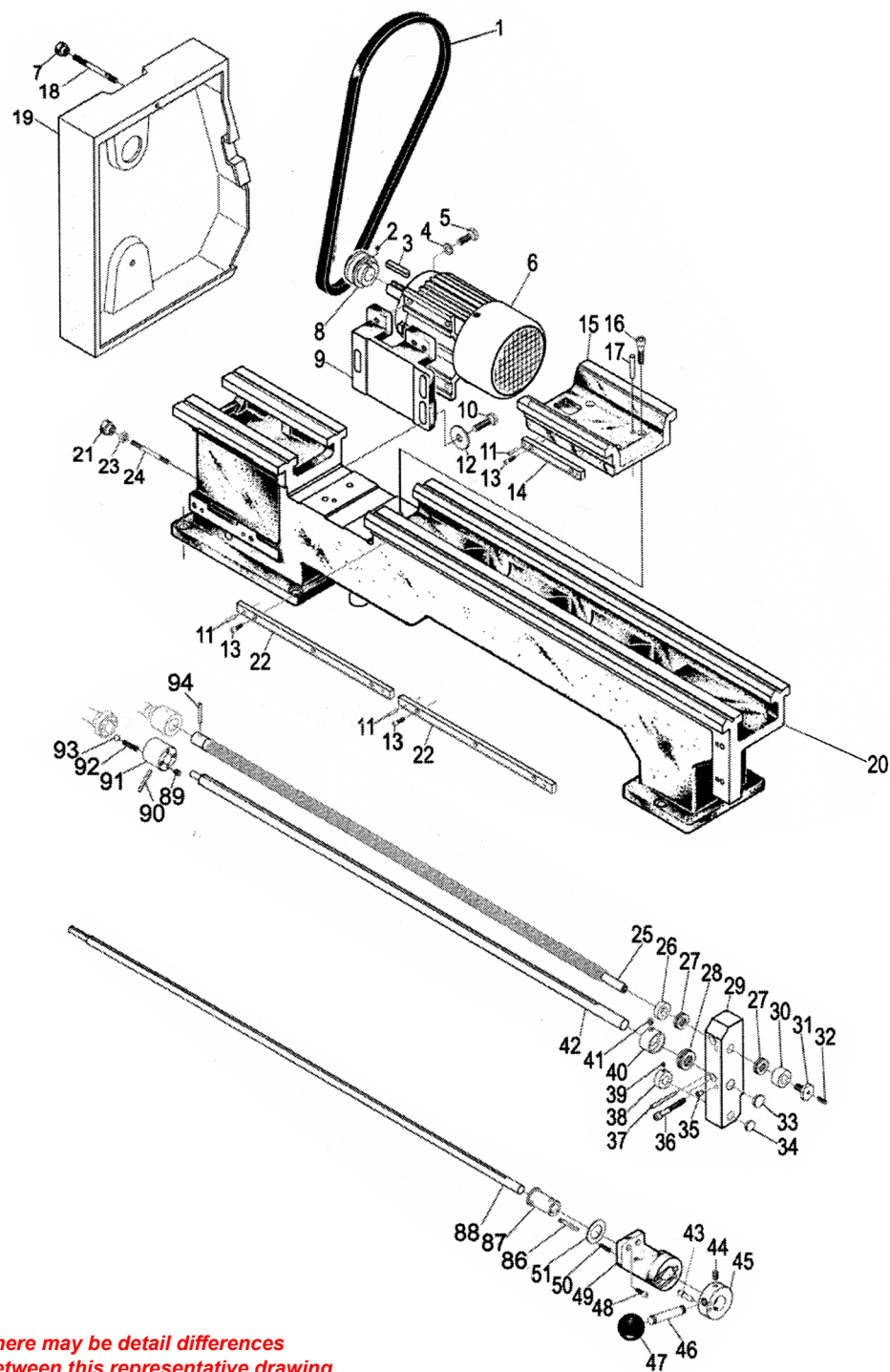


Motor control cam

STAND COMPONENTS Fig 1a



LATHE BED COMPONENTS Fig 1b



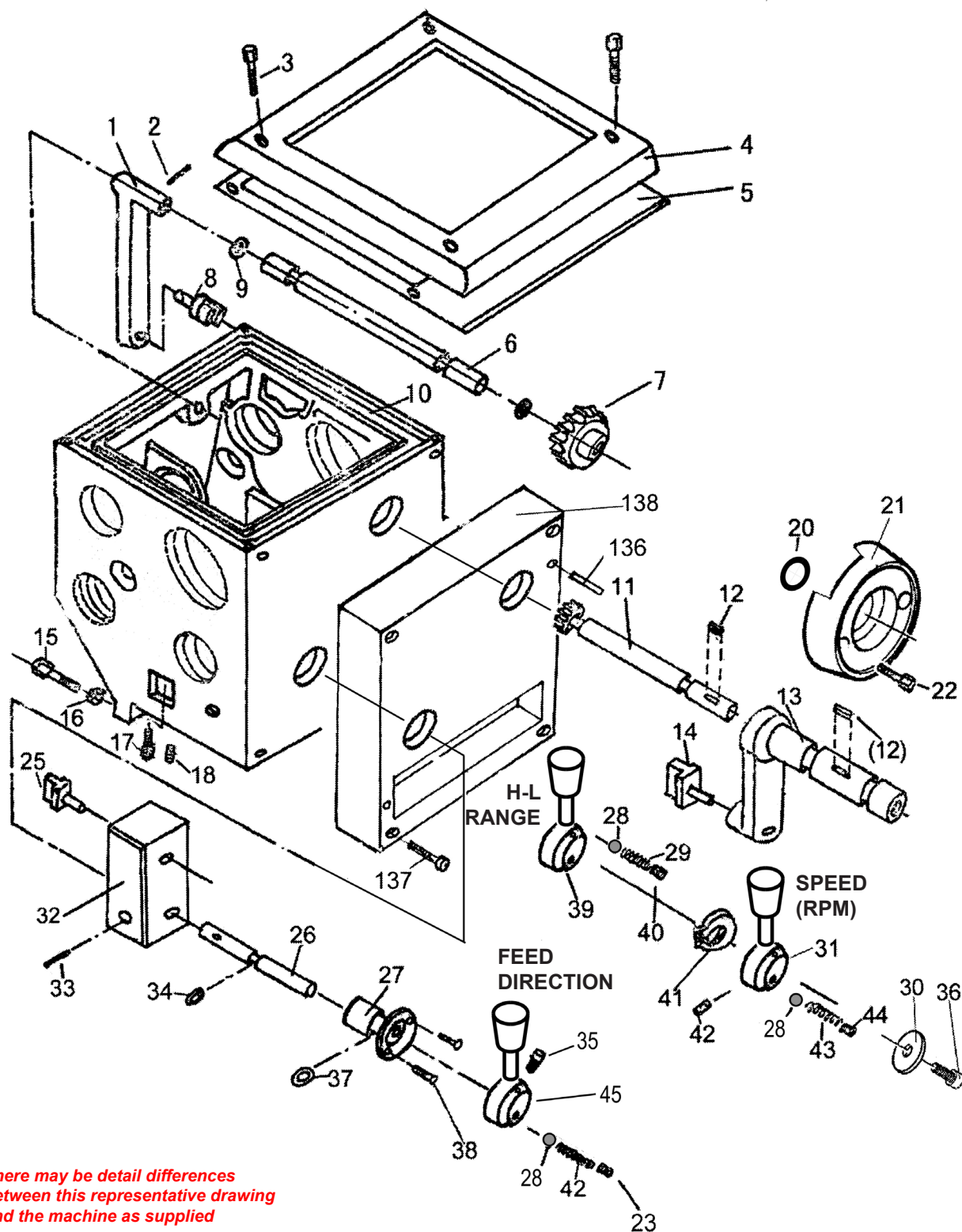
*There may be detail differences
between this representative drawing
and the machine as supplied*

STAND & BED **Fig 1**

Ref	Description	Part	Ref	Description	Part	Ref	Description	Part
1	Belt A813	Z4110	33	Plug	Z4142	64	RH stand	Z4173
2	Screw M6×12	Z4111	34	Plug	Z4143	65	Cover plate	Z4174
3	Key	Z4112	35	Oiler	Z4144	66	Cover plate	Z4175
4	Washer 8	Z4113	36	Screw M8×60	Z4145	67	Screw	Z4176
5	Bolt M8×25	Z4114	37	Taper pin 5×60	Z4146	68	Spring	Z4177
6	Motor	Z4115	38	Sleeve	Z4147	69	Treadle arm	Z4178
7	Clamp knob	Z4116	39	Set screw M6×8	Z4148	70	Pin	Z4179
8	Pulley	Z4117	40	Bearing cover	Z4149	71	Pin 3×25	Z4180
9	Bracket	Z4118	41	Set screw M8×10	Z4150	72	Shaft	Z4181
10	Bolt M10×30	Z4119	42	Feed shaft	Z4151	73	Screw M8×6	Z4182
11	Pin 6×26	Z4120	43	Pin	Z4152	74	Nut	Z4183
12	Washer	Z4121	44	Set screw 8×16	Z4153	75	Pin 5×40	Z4184
13	Screw M6×25	Z4122	45	Collar	Z4154	76	Treadle shaft	Z4185
14	Rack	Z4123	46	Motor control lever	Z4155	77	Brake	Z4186
15	Gap filler	Z4124	47	Knob	Z4156	78	Screw M6×10	Z4187
16	Screw M10×40	Z4125	48	Screw M6×16	Z4157	79	Screw M12×50	Z4188
17	Taper pin 8×60	Z4126	49	Bracket	Z4158	80	Screw M6×10	Z4189
18	Stud	Z4127	50	Compression spring	Z4159	81	Screw	Z4190
19	Cover	Z4128	51	Washer	Z4160	82	LH bracket	Z4191
20	Lathe bed	Z4129	52	Screw M5×6	Z4161	83	Screw M6×10	Z4192
21	Clamp knob	Z4130	53	Cover plate	Z4162	84	Front plate	Z4193
22	Rack	Z4131	54	Splash guard	Z4163	85	RH bracket	Z4194
23	Nut M10	Z4132	55	Screw M6×10	Z4164	86	Key	Z4195
24	Stud	Z4133	56	Screw M6×20	Z4165	87	Sleeve	Z4196
25	Lead screw	Z4134	57	Washer 6	Z4166	88	Motor control rod	Z4197
26	Sleeve	Z4135	58	Pin 2×12	Z4167	89	Screw M8×10	Z4198
27	Bearing 8102	Z4136	59	Pin	Z4168	90	Pin 5×40	Z4199
28	Bearing 8104	Z4137	60	Tray	Z4169	91	Sleeve	Z4200
29	Bracket	Z4138	61	Cover plate	Z4170	92	Spring	Z4201
30	Bearing cover	Z4139	62	Pull rod	Z4171	93	Steel ball 6	Z4202
31	Lock screw	Z4140	63	LH stand	Z4172	94	Shear pin	Z4203
32	Set screw M6×20	Z4141						

Dimensions in millimeters

HEADSTOCK (1) **Fig 2**



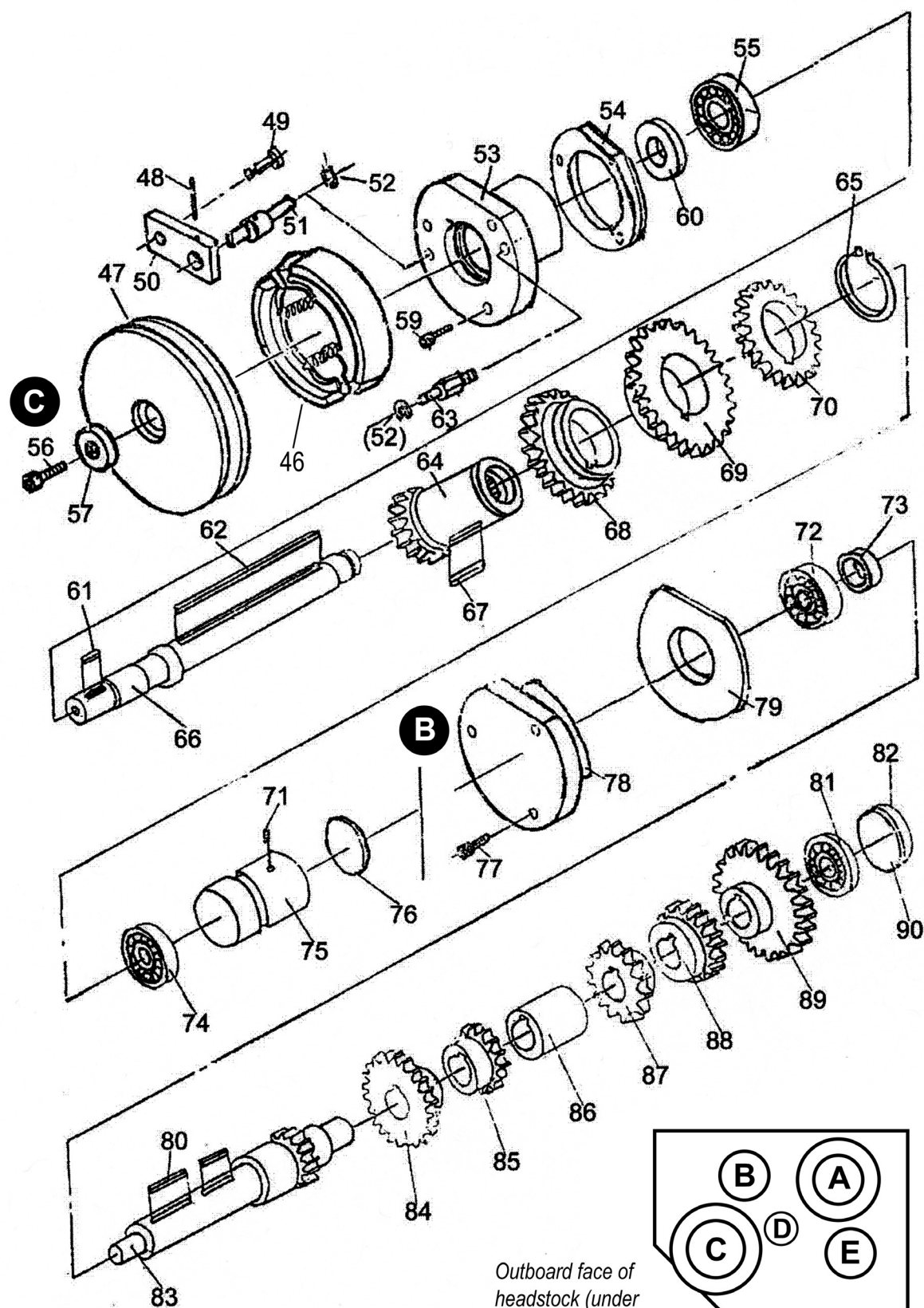
HEADSTOCK (1) Fig 2

Ref	Description	Part
1	Shift arm	Z4204
2	Pin 5×32	Z4205
3	Screw M6×18	Z4206
4	Cover	Z4207
5	Gasket	Z4208
6	Shaft	Z4209
7	Gear	Z4210
8	Shift tongue	Z4211
9	O-Ring 14×2.4	Z4212
10	Headstock casting	Z4213
11	Geared shaft	Z4214
12	Key 5×15	Z4215
13	Crank	Z4216
14	Shift tongue	Z4217
15	Screw M8×45	Z4218
16	Nut M8	Z4219
17	Screw M10×35	Z4220
18	Screw M8×12	Z4221
19	Washer	Z4222
20	O-Ring 30×3.1	Z4223
21	Flange	Z4224
22	Screw M6×35	Z4225
23	Set screw M6×16	Z4226
25	Shift tongue	Z4227

Ref	Description	Part
26	Shaft	Z4228
27	Collar	Z4229
28	Steel ball 6	Z4230
29	Spring 1×6×7	Z4231
30	Washer	Z4232
31	Handle (RPM)	Z4233
32	Shift block	Z4234
33	Pin 4×18	Z4235
34	O-Ring 10×1.9	Z4236
35	Screw M6×16	Z4237
36	Screw, flt hd	Z4238
37	O-Ring 20×2.4	Z4239
38	Screw M4×8	Z4240
39	Handle (H-L)	Z4241
40	Set screw M8×8	Z4242
41	Circlip 30	Z4243
42	Spring 0.6×4.4×16	Z4244
43	Spring 1×6×20	Z4245
44	Set screw M8×10	Z4246
45	Handle (Feed direction)	Z4247
136	Taper Pin 6×60	Z4248
137	Screw M6×50	Z4249
138	Front casting	Z4250

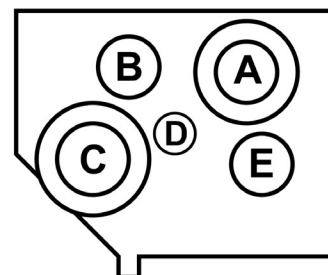
Dimensions in millimeters

HEADSTOCK (2) Fig 3



There may be detail differences between this representative drawing and the machine as supplied

Outboard face of headstock (under belt cover)



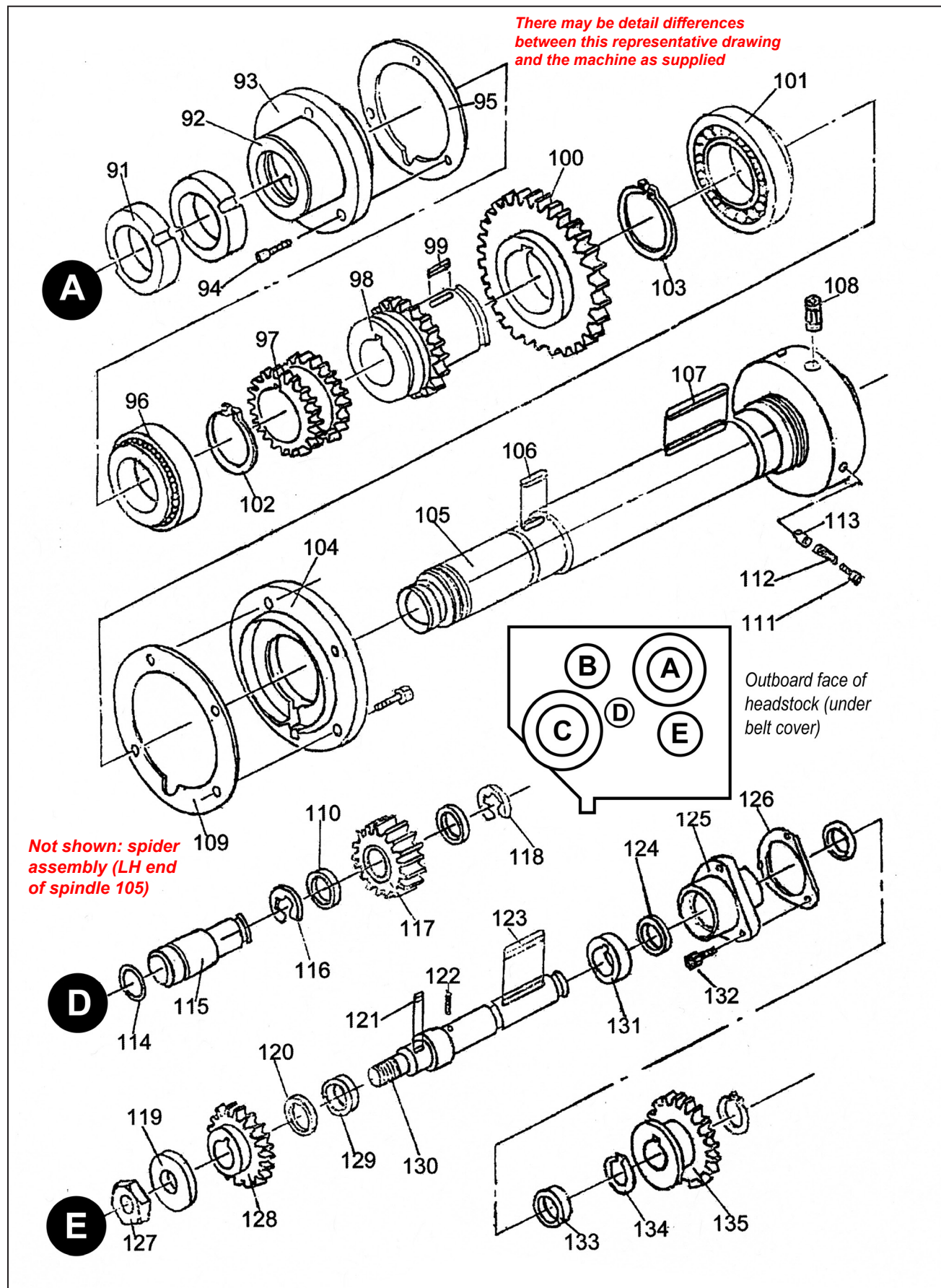
HEADSTOCK (2) Fig 3

Ref	Description	Part
46	Brake shoe assembly	Z4251
47	Pulley (brake drum)	Z4252
48	Pin 5×25	Z4253
49	Stud	Z4254
50	Rocker bar	Z4255
51	Shaft	Z4256
52	Circlip 8	Z4257
53	Flange	Z4258
54	Gasket	Z4259
55	Ball bearing	Z4260
56	Screw M8×15	Z4261
57	Washer	Z4262
59	Screw M6×16	Z4263
60	Oil Seal SD25×40×10	Z4264
61	Key 8×20	Z4265
62	Key 6×120	Z4266
63	Rocker stud	Z4267
64	Gear collar	Z4268
65	Circlip 35	Z4269
66	'C' Shaft	Z4270
67	Key 5×50	Z4271
68	Gear 29 (2)	Z4272

Ref	Description	Part
69	Gear 46 (2)	Z4273
70	Gear 38 (2)	Z4274
71	Screw M8×16	Z4275
72	Ball bearing	Z4276
73	Spacer	Z4277
74	Ball bearing	Z4278
75	Plug	Z4279
76	O-Ring 40×3.1	Z4280
77	Screw M4×12	Z4281
78	Cover	Z4282
79	Gasket	Z4283
80	Key 6×55	Z4284
81	Ball bearing	Z4285
82	O-Ring 47×3.1	Z4286
83	Geared shaft	Z4287
84	Gear 51 (2)	Z4288
85	Gear 43 (2)	Z4289
86	Spacer	Z4290
87	Gear 26 (2)	Z4291
88	Gear 34 (2)	Z4292
89	Gear 53 (2.25)	Z4293
90	Plug	Z4294

Dimensions in millimeters

HEADSTOCK (3) **Fig 4**



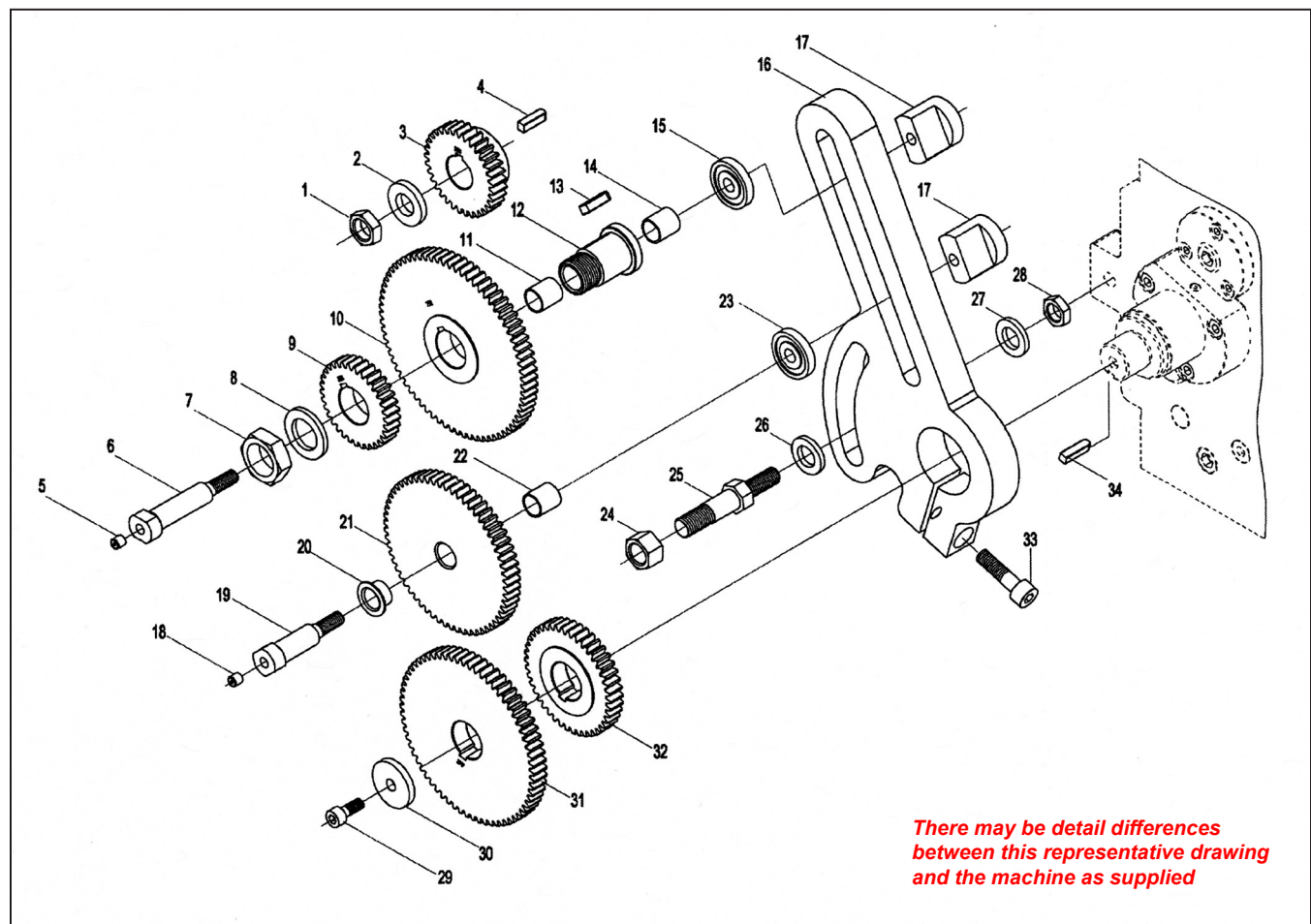
HEADSTOCK (3) Fig 4

Ref	Description	Part
91	Spanner nut	Z4295
92	Collar	Z4296
93	Flange	Z4297
94	Screw M6×25	Z4298
95	Gasket	Z4299
96	Tapered roller bearing	Z4300
97	Gear 37 (2)	Z4301
98	Gear 37 (2.25)	Z4302
99	Key 8×18	Z4303
100	Gear 74 (2.25)	Z4304
101	Tapered roller bearing	Z4305
102	Circlip 50	Z4306
103	Circlip 72	Z4307
104	Flange	Z4308
105	Spindle	Z4309
106	Key 6×40	Z4310
107	Key 8×85	Z4311
108	Cam (Camlock)	Z4312
109	Gasket	Z4313
110	Ball bearing	Z4314
111	Screw M6×18	Z4315
112	Spring	Z4316
113	Camlock stud	Z4317

Ref	Description	Part
114	O-Ring 25×2.4	Z4318
115	'D' Shaft	Z4319
116	Circlip 42	Z4320
117	Gear 30	Z4321
118	Circlip 42	Z4322
119	Washer	Z4323
120	Washer	Z4324
121	Key 5×18	Z4325
122	Pin 3×10	Z4326
123	Key 6×50	Z4327
124	Collar	Z4328
125	Flange	Z4329
126	Gasket	Z4330
127	Nut M12	Z4331
128	Gear 32	Z4332
129	Oil Seal	Z4333
130	'E' Shaft	Z4334
131	Spacer	Z4335
132	Screw M5×16	Z4336
133	Spacer	Z4337
134	Circlip 20	Z4338
135	Gear 37	Z4339

Dimensions in millimeters

EXTERNAL CHANGE GEARS Fig 5

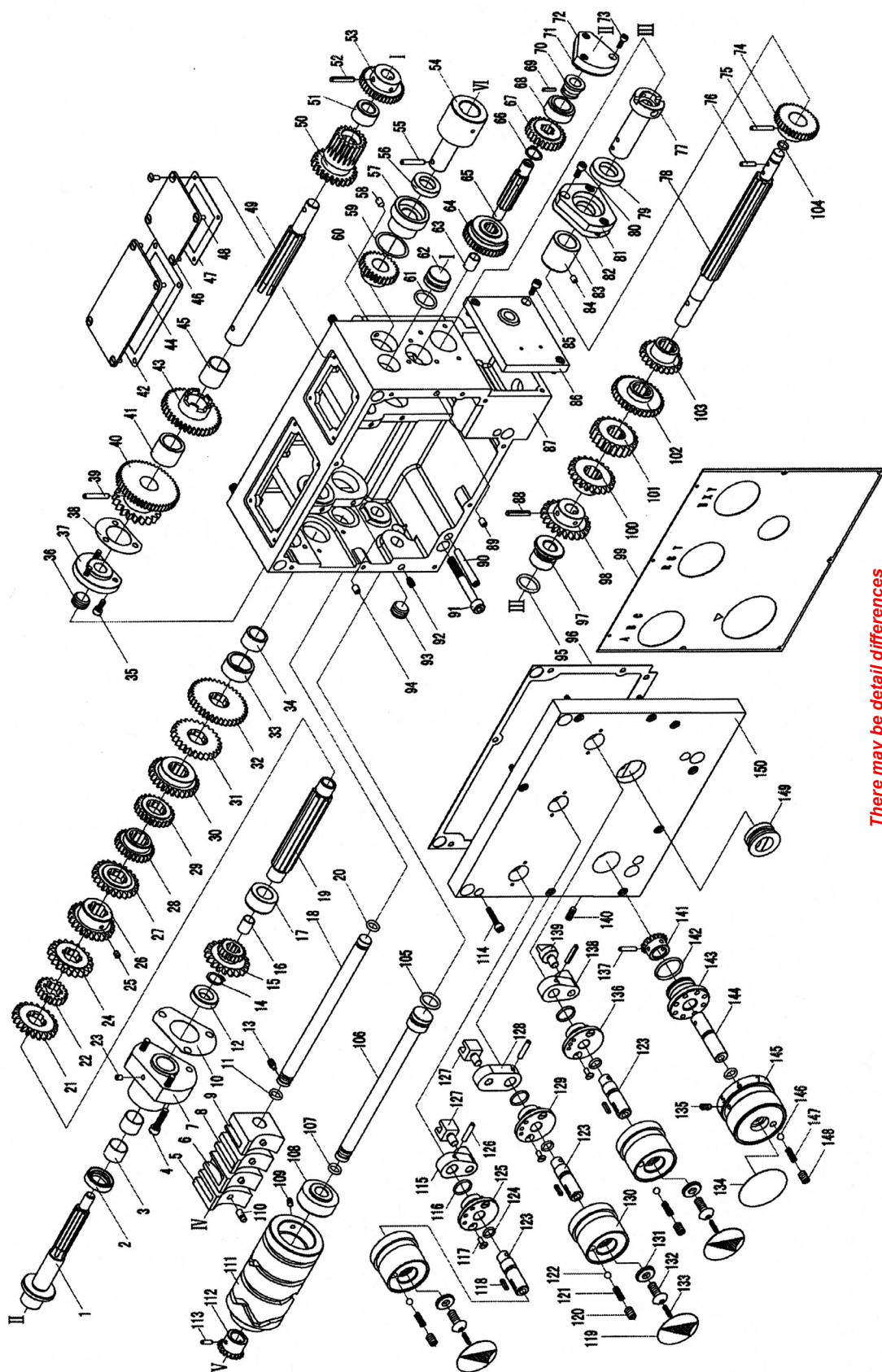


Ref	Description	Part
1	Nut M12	Z4340
2	Washer	Z4341
3	Gear 32T	Z4342
4	Key C5×18	Z4343
5	Oiler	Z4344
6	Shaft	Z4345
7	Nut	Z4346
8	Washer	Z4347
9	Gear 33T	Z4348
10	Gear 76T	Z4349
11	Bushing	Z4350
12	Bushing	Z4351
13	Key 5×20	Z4352
14	Bushing	Z4353
16	Gear quadrant	Z4354
17	T-nut	Z4355

Ref	Description	Part
19	Shaft	Z4356
20	Bushing	Z4357
21	Gear 61T	Z4358
22	Bushing	Z4359
23	Washer	Z4360
24	Nut M12	Z4361
25	Shaft	Z4362
26	Washer	Z4363
27	Washer	Z4364
28	Nut M10	Z4365
29	Screw M6×16	Z4366
30	Washer	Z4367
31	Gear 66T	Z4368
32	Gear 42T	Z4369
33	Screw M8×30	Z4370
34	Key 5×20	Z4371

Dimensions in millimeters

SADDLE FEED QC GEARBOX Fig 6



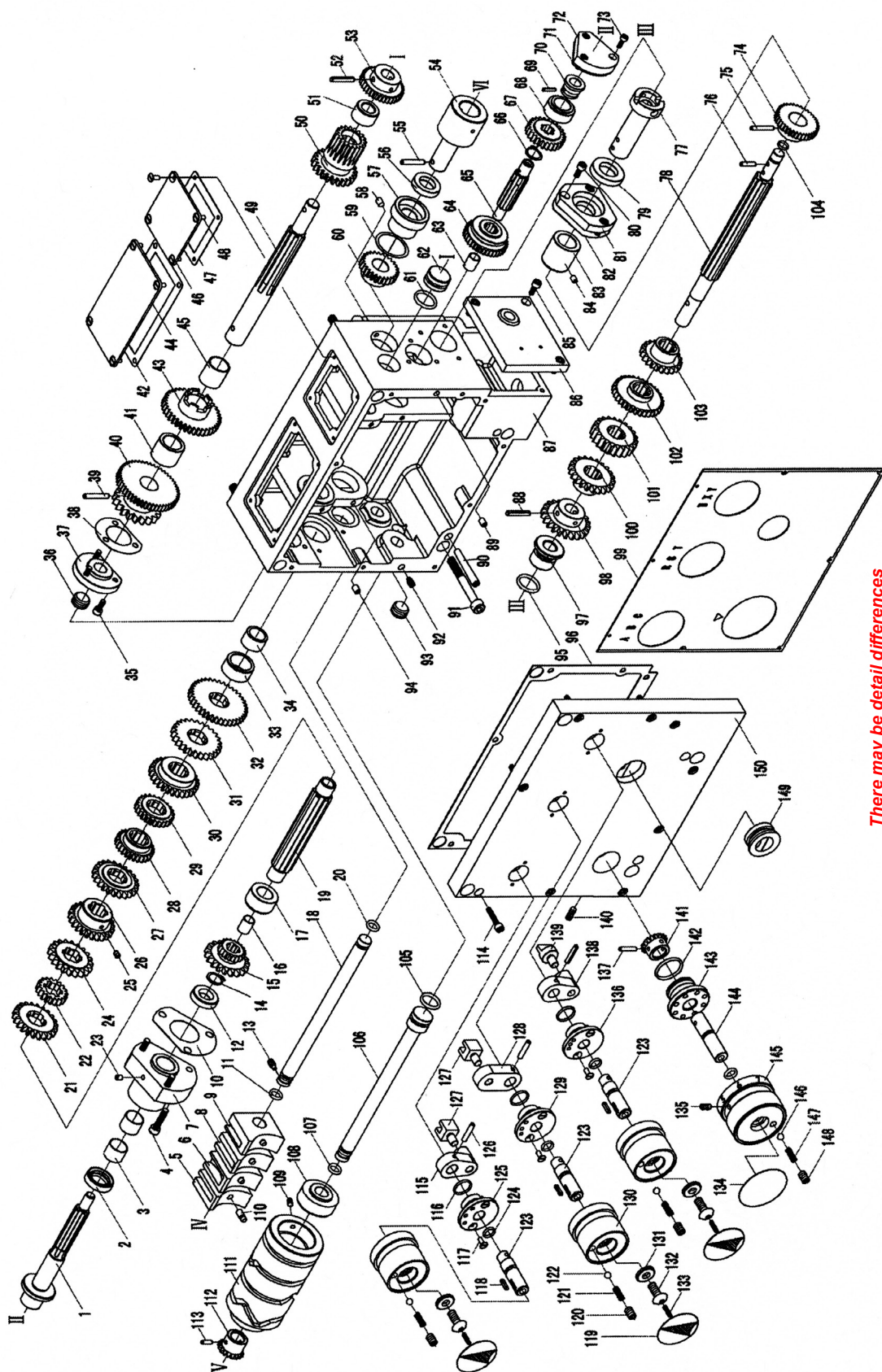
There may be detail differences
between this representative drawing
and the machine as supplied

SADDLE FEED QC GEARBOX **Fig 6**

Ref	Description	Part	Ref	Description	Part	Ref	Description	Part
1	Splined shaft	Z4372	32	Gear 38T	Z4403	63	Bush	Z4434
2	Oil seal	Z4373	33	Bushing	Z4404	64	Gear 35T	Z4435
3	Bushing	Z4374	34	Bushing	Z4405	65	Splined shaft	Z4436
4	Screw M6×25	Z4375	35	Screw M5×12	Z4406	66	Retaining ring 16	Z4437
5	Shift fork	Z4376	36	Oil plug 3/8"	Z4407	67	Gear 26T	Z4438
6	Shift fork	Z4377	37	Fill flange	Z4408	68	Bushing	Z4439
7	Flange	Z4378	38	Gasket	Z4409	69	Roll pin 3×16	Z4440
8	Shift fork	Z4379	39	Roll pin 5×30	Z4410	70	Sleeve	Z4441
9	Shift fork	Z4380	40	Gear assy 19T/50T	Z4411	71	Gasket	Z4442
10	Gasket	Z4381	41	Bushing	Z4412	72	Cover plate	Z4443
11	O-Ring 9.5×2.65	Z4382	42	Gasket	Z4413	73	Screw M4×12	Z4444
12	Spacer	Z4383	43	Gear 38T + dog	Z4414	74	Gear 36T	Z4445
13	Screw M5×12	Z4384	44	LH top cover	Z4415	75	Roll pin 4×28	Z4446
14	Retaining ring 16	Z4385	45	Bushing	Z4416	76	Roll pin 4×18	Z4447
15	Gear assy 19T/20T	Z4386	46	RH top cover	Z4417	77	Output coupler – feed shaft	Z4448
16	Bushing	Z4387	47	Gasket	Z4418	78	Splined shaft	Z4449
17	Bushing	Z4388	48	Screw M4×10	Z4419	79	Oil Seal	Z4450
18	Shaft	Z4389	49	Splined shaft	Z4420	80	Screw M5×12	Z4451
19	Splined shaft	Z4390	50	Gear assy 23T/19T	Z4421	81	Flange	Z4452
20	O-Ring 9.5×2.65	Z4391	51	Bushing	Z4422	82	Gasket	Z4453
21	Gear 22T	Z4392	52	Roll pin 5×28	Z4423	83	Bushing	Z4454
22	Gear 19T	Z4393	53	Gear 35T	Z4424	84	Screw M6×14	Z4455
23	Oiler 6	Z4394	54	Output coupler - leadscrew	Z4425	85	Screw M5×12	Z4456
24	Gear 20T	Z4395	55	Roll pin 5×28	Z4426	86	Cover plate	Z4457
25	Set screw M5×8	Z4396	56	Oil seal	Z4427	87	Gear case	Z4458
26	Gear 24T	Z4397	57	Shouldered bushing	Z4428	88	Roll pin 5×28	Z4459
27	Gear 23T	Z4398	58	Screw M6×10	Z4429	89	Screw M6×14	Z4460
28	Gear 27T	Z4399	59	Gasket	Z4430	90	Taper pin 6×50	Z4461
29	Gear 24T	Z4400	60	Gear 26T	Z4431	91	Screw M8×65	Z4462
30	Gear 28T	Z4401	61	O-ring 25×1.8	Z4432	92	Screw M5×12	Z4463
31	Gear 26T	Z4402	62	Plug	Z4433			

Dimensions in millimeters

SADDLE FEED QC GEARBOX Fig 7



There may be detail differences
between this representative drawing
and the machine as supplied

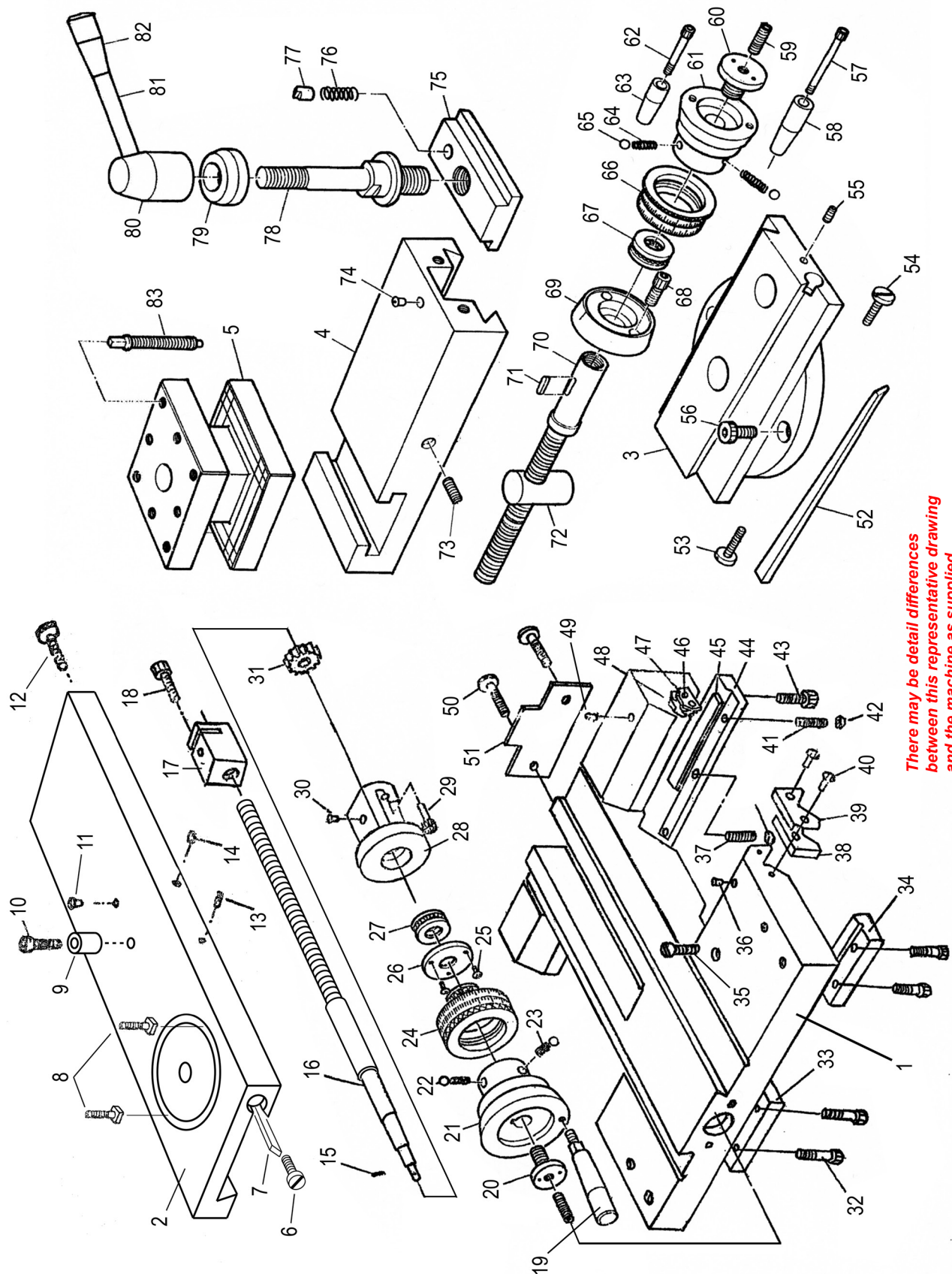
SADDLE FEED QC GEARBOX Fig 7

Ref	Description	Part
93	Oil plug 3/8"	Z4464
94	Screw M6×14	Z4465
95	O-ring 20×2.65	Z4466
96	Gasket	Z4467
97	Bushing	Z4468
98	Gear 22T	Z4469
99	Face plate	Z4470
100	Gear 22T	Z4471
101	Gear 22T	Z4472
102	Gear 33T	Z4473
103	Gear 22T	Z4474
104	O-ring 9×1.8	Z4475
105	O-ring 17×2.65	Z4476
106	Shaft	Z4477
107	O-ring 25×2.65	Z4478
108	Bushing	Z4479
109	Screw M5×10	Z4480
110	Ball headed pin	Z4481
111	Cam assy	Z4482
112	Bevel gear 18T	Z4483
113	Roll pin 4×12	Z4484
114	Screw M5×25	Z4485
115	Shifter arm	Z4486
116	O-Ring 17×1.8	Z4487
117	Screw M4×10	Z4488
118	Key A3×14	Z4489
119	Arrow disc	Z4490
120	Screw M8×12	Z4491
121	Spring 1×5×20	Z4492

Ref	Description	Part
122	Steel ball 1/4"	Z4493
123	Shaft	Z4494
124	O-ring 9.5×2.65	Z4495
125	Shifter flange	Z4496
126	Roll pin 4×24	Z4497
127	Shift fork	Z4498
128	Shifter arm	Z4499
129	Shifter flange	Z4500
130	Knob	Z4501
131	Washer	Z4502
132	Screw	Z4503
133	Screw M4×20	Z4504
134	Plain disc	Z4505
135	Screw M6×14	Z4506
136	Shifter flange	Z4507
137	Roll pin 4×20	Z4508
138	Shifter arm	Z4509
139	Shift tongue	Z4510
140	Screw M6×16	Z4511
141	Bevel gear 18T	Z4512
142	O-ring 20×2.65	Z4513
143	Shifter flange	Z4514
144	Shaft	Z4515
145	Knob	Z4516
146	Steel ball 1/4"	Z4517
147	Spring 1×5×20	Z4518
148	Screw M8×12	Z4519
149	Sight glass	Z4520
150	Gear case front plate	Z4521

Dimensions in millimeters

SADDLE - CROSS SLIDE - COMPOUND Fig 8



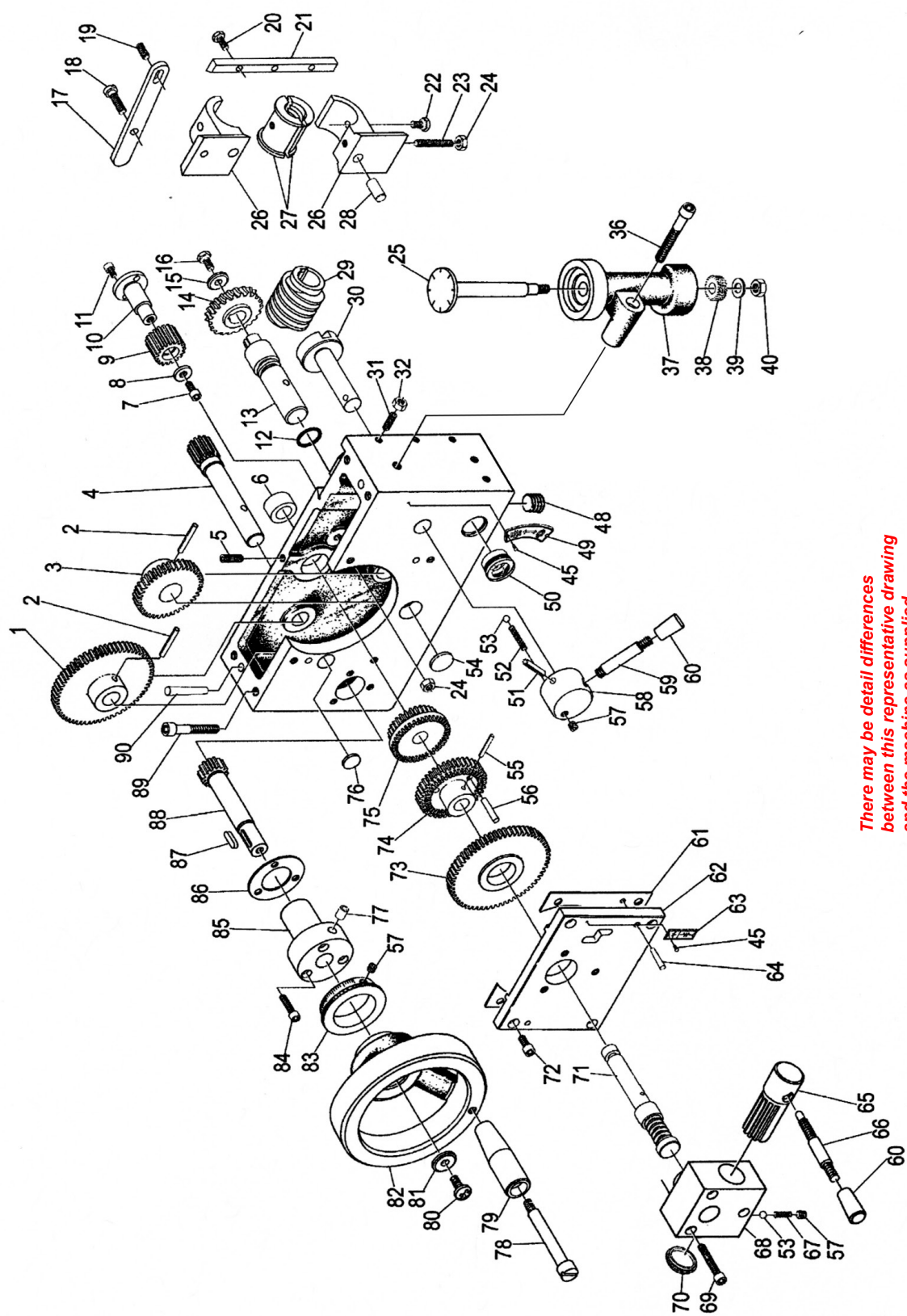
There may be detail differences between this representative drawing and the machine as supplied

SADDLE - CROSS SLIDE - COMPOUND Fig 8

Ref	Description	Part	Ref	Description	Part	Ref	Description	Part
1	Saddle casting	Z4522	29	Screw	Z4550	57	Shoulder screw	Z4578
2	Cross slide	Z4523	30	Oiler	Z4551	58	Handle	Z4579
3	Compound swivel base	Z4524	31	Gear	Z4552	59	Set screw M6	Z4580
4	Compound slide	Z4525	32	Screw M8	Z4553	60	Flange screw	Z4581
5	4-way toolpost	Z4526	33	LH gib plate	Z4554	61	Handwheel	Z4582
6	Gib screw	Z4527	34	RH gib plate	Z4555	62	Shoulder screw	Z4583
7	Cross slide gib	Z4528	35	Screw M8	Z4556	63	Handle	Z4584
8	T-screw (or T-nut)	Z4529	36	Oiler	Z4557	64	Compression spring	Z4585
9	Bushing	Z4530	37	Set screw M6	Z4558	65	Steel ball	Z4586
10	Screw	Z4531	38	Wiper	Z4559	66	Graduated collar	Z4587
11	Oiler	Z4532	39	Backing plate	Z4560	67	Thrust bearing	Z4588
12	Gib screw	Z4533	40	Screw	Z4561	68	Screw M6	Z4589
13	Set screw M6	Z4534	41	Set screw M6	Z4562	69	Flange	Z4590
14	Set screw M8	Z4535	42	Nut	Z4563	70	Compound leadscrew	Z4591
15	Roll pin	Z4536	43	Screw M8	Z4564	71	Key	Z4592
16	Cross slide leadscrew	Z4537	44	Gib support	Z4565	72	Compound leadscrew nut	Z4593
17	Leadscrew nut	Z4538	45	Gib	Z4566	73	Set screw M8	Z4594
18	Backlash take-up M6	Z4539	46	Screw	Z4567	74	Oiler	Z4595
19	Handle	Z4540	47	Backing plate	Z4568	75	T-plate	Z4596
20	Flange screw	Z4541	48	Wiper	Z4569	76	Compression spring	Z4597
21	Handwheel	Z4542	49	Oiler	Z4570	77	Detent plunger	Z4598
22	Steel ball	Z4543	50	Screw M8	Z4571	78	Toolpost stud	Z4599
23	Compression spring	Z4544	51	Cover plate	Z4572	79	Washer	Z4600
24	Graduated collar	Z4545	52	Compound gib	Z4573	80	Clamp nut	Z4601
25	Screw	Z4546	53	Gib screw	Z4574	81	Lever	Z4602
26	Support disc	Z4547	54	Gib screw	Z4575	82	Knob	Z4603
27	Thrust bearing	Z4548	55	Set screw M6	Z4576	83	Screw	Z4604
28	Support flange	Z4549	56	M8 screw (or nut)	Z4577			

Dimensions in millimeters

APRON **Fig 9**



There may be detail differences
between this representative drawing
and the machine as supplied

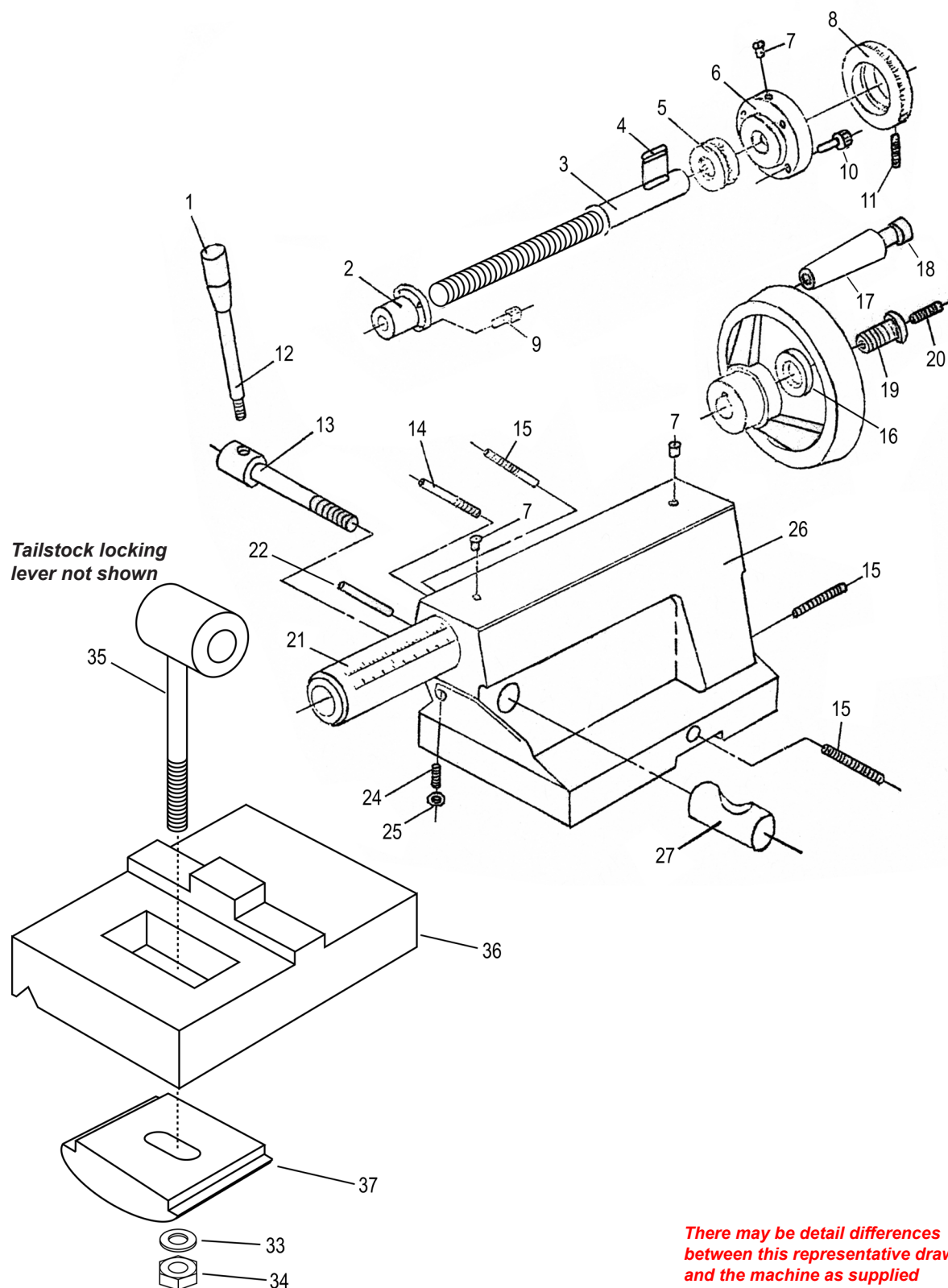
APRON **Fig 9**

Ref	Description	Part
1	Gear 60T	Z4605
2	Roll pin 5×30	Z4606
3	Gear 18T	Z4607
4	Pinion shaft 11T	Z4608
5	Set screw M6×16	Z4609
6	Sleeve	Z4610
7	Screw M6×12	Z4611
8	Washer	Z4612
9	Gear	Z4613
10	Idler shaft	Z4614
11	Screw M5×12	Z4615
12	O-ring	Z4616
13	Worm gear shaft	Z4617
14	Worm gear	Z4618
15	Washer	Z4619
16	Screw M6×12	Z4620
17	Interlock	Z4621
18	Screw	Z4622
19	Screw M6×12	Z4623
20	Screw M5×20	Z4624
21	Split nut gib	Z4625
22	Screw M6×10	Z4626
23	Screw M6×35	Z4627
24	Nut M6	Z4628
25	Indicator dial	Z4629
26	Split nut holder	Z4630
27	Split nut half	Z4631
28	Dowel pin 8×16	Z4632
29	Worm	Z4633
30	Split nut camshaft	Z4634
31	Screw M5×16	Z4635
32	Nut M5	Z4636
36	Screw M8×50	Z4637
37	Dial indicator housing	Z4638
38	Helical gear 32T	Z4639
39	Washer	Z4640
40	Nut M8	Z4641
48	Drain plug 1/8"	Z4642
49	Split nut indicator	Z4643
50	Sight glass	Z4644

Ref	Description	Part
51	Roll pin 5×35	Z4645
52	Spring	Z4646
53	Steel ball 3/16"	Z4647
54	Plug	Z4648
55	Roll pin 3×25	Z4649
57	Screw M6×6	Z4650
58	Lever hub	Z4651
59	Lever	Z4652
60	Knob	Z4653
61	Spacer plate	Z4654
62	Front cover	Z4655
63	Feed selection indicator	Z4656
64	Taper pin 5×20	Z4657
65	Splined shaft	Z4658
66	Lever	Z4659
67	Spring	Z4660
68	Block	Z4661
69	Screw M6×35	Z4662
70	Plug	Z4663
71	Feed selection shaft	Z4664
72	Screw M6×16	Z4665
73	Gear	Z4666
74	Gear	Z4667
75	Gear assy	Z4668
76	Plug	Z4669
77	Oiler	Z4670
78	Shoulder screw	Z4671
79	Handle	Z4672
80	Screw M6×15	Z4673
81	Washer	Z4674
82	Handwheel	Z4675
83	Graduated collar	Z4676
84	Screw M5×25	Z4677
85	Handwheel flange	Z4678
86	Spacer	Z4679
87	Key 5×5×20	Z4680
88	Pinion shaft	Z4681
89	Screw M8×30	Z4682
90	Taper pin 8×40	Z4683

Dimensions in millimeters

TAILSTOCK Fig 10

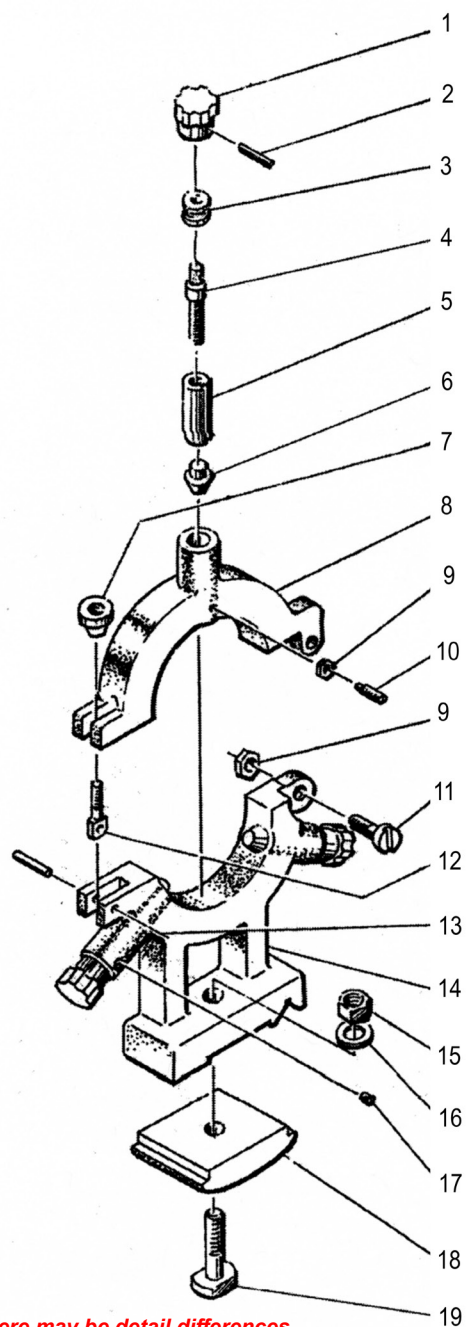


TAILSTOCK Fig 10

Ref	Description	Part
1	Knob M8	Z4684
2	Nut	Z4685
3	Leadscrew	Z4686
4	Key 4×15	Z4687
5	Thrust bearing	Z4688
6	Flange	Z4689
7	Oiler	Z4690
8	Graduated collar	Z4691
9	Screw M4×10	Z4692
10	Screw M6×16	Z4693
11	Screw M6×10	Z4694
12	Quill lock lever	Z4695
13	Quill lock rod	Z4696
14	Screw	Z4697
15	Screw M10×45	Z4698
16	Washer	Z4699
17	Handle	Z4700
18	Shoulder screw	Z4701
19	Flange screw	Z4702
20	Screw M5×18	Z4703
21	Quill	Z4704
22	Screw	Z4705
23	Handwheel	Z4706
24	Set screw M8×35	Z4707
25	Nut M8	Z4708
26	Tailstock casting	Z4709
27	Quill clamp block	Z4710
33	Washer	Z4711
34	Nut M12	Z4712
35	Lock screw assembly	Z4713
36	Base casting	Z4714
37	Clamp block	Z4715

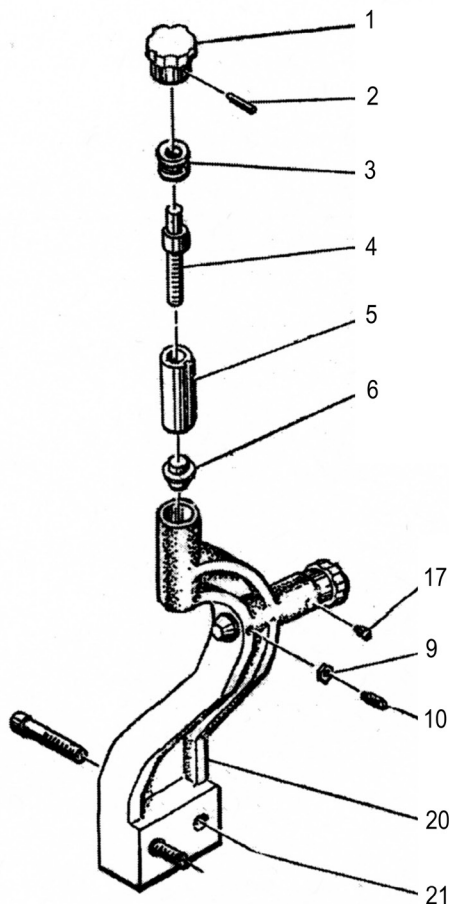
Dimensions in millimeters

RESTS Fig 11



*There may be detail differences
between this representative drawing
and the machine as supplied*

Ref	Description	Part
1	Knob	Z4716
2	Roll pin 3×18	Z4717
3	Collar	Z4718
4	Jack screw	Z4719
5	Collar	Z4720
6	Contact head	Z4721



Ref	Description	Part
7	Knurled nut	Z4722
8	Upper casting	Z4723
9	Nut M6	Z4724
10	Screw M6×18	Z4725
11	Screw M6×30	Z4726
12	Clamp screw	Z4727
13	Dowel pin 5×24	Z4728
14	Lower casting	Z4729
15	Nut M12	Z4730
16	Washer	Z4731
17	Screw M6×6	Z4732
18	Clamp block	Z4733
19	T-screw M12	Z4734
20	Follow Rest	Z4735
21	Screw M8×45	Z4736